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SULPHUR

THE MAGAZINE OF WORLD SULPHUR

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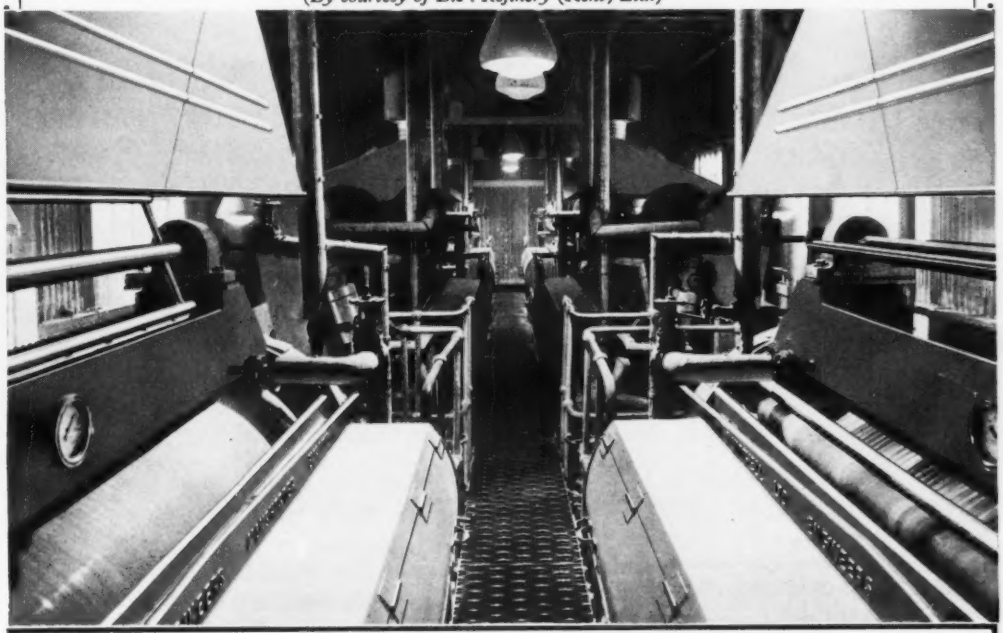

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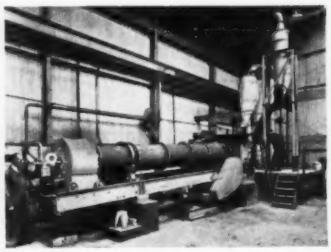

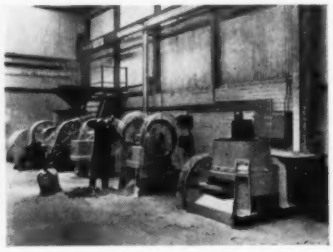

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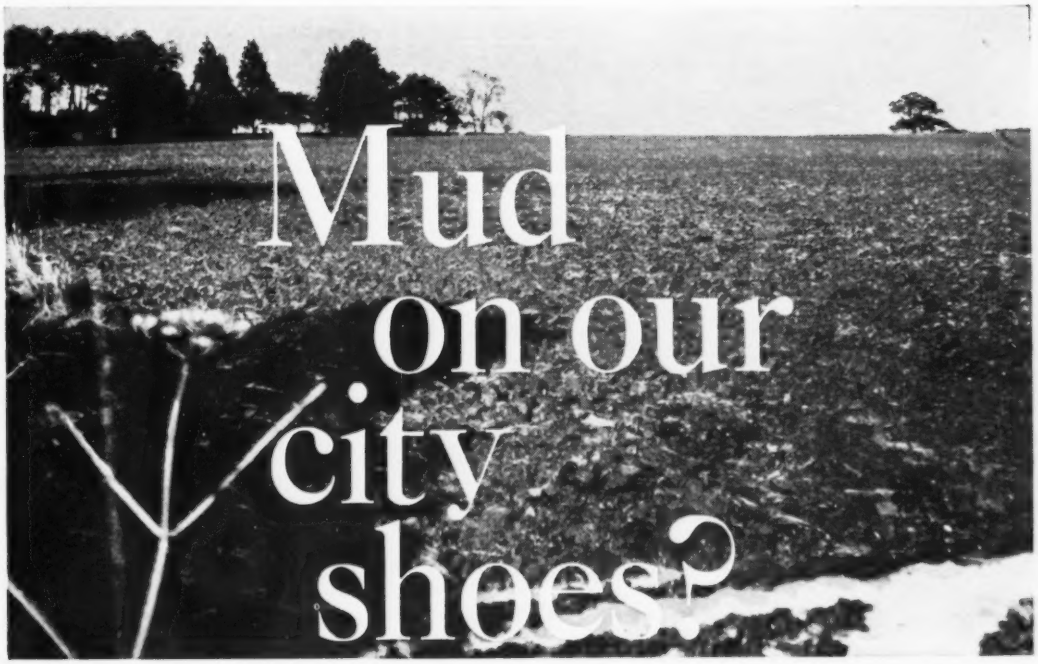

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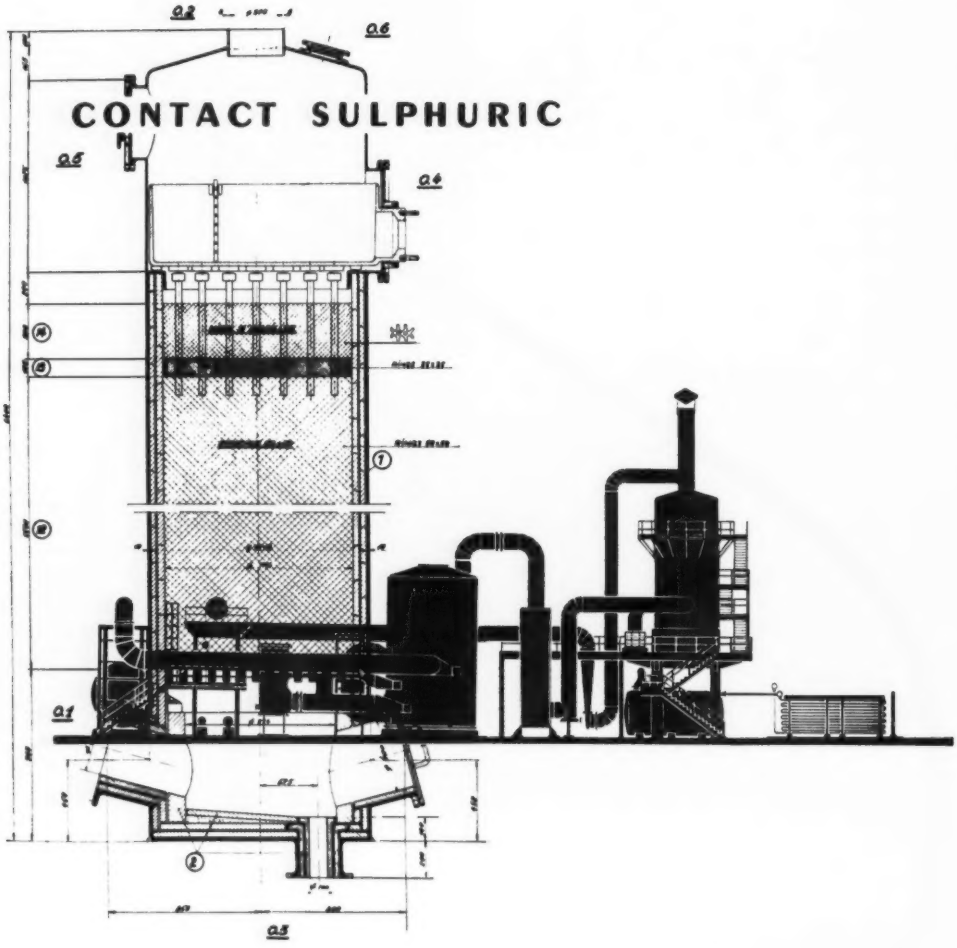

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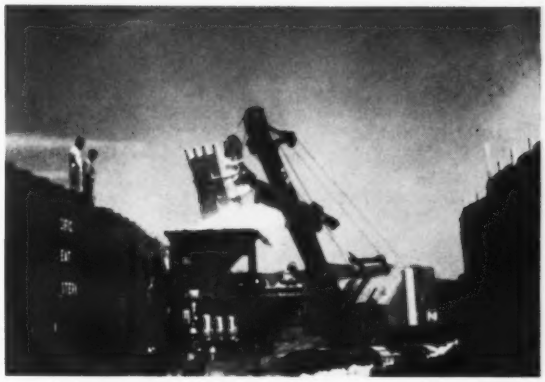
Canada's Sulphur Industry in 1959 and 1960



Jefferson Lake Sulphur Company Peace River sulphur recovery plant. First shipment of sulphur from Fort St. John in August 1958

PRODUCTION of sulphur from natural gas in Canada is increasing rapidly. According to a report issued by the *Canadian Department of Mines and Technical Surveys*, it is estimated that by 1965 production from this source will be between 3 and 4 million short tons a year. Some of the problems raised by this quantity of sulphur can be judged when it is realised that total production of sulphur from natural gas in 1959 was only 293,000 short tons and that total consumption in the whole of Canada of sulphur in all forms—including sulphur shipped as pyrite and pyrrhotite, sulphur in smelter gases and by-product ammonium sulphate from nickel refining—was only 1.05 million short tons.

Sulphur Production
(short tons)

	In Pyrites Shipped (1)	In Smelter Gases (2)	Elemental Sulphur (3)	Total
1949	117,581	144,290	—	261,871
1950	150,487	150,685	—	301,172
1951	215,363	156,427	—	371,790
1952	263,241	160,547	8,931	432,719
1953	186,650	172,200	18,298	377,148
1954	311,159	221,247	22,320	554,726
1955	403,986	224,457	29,093	657,536
1956	473,605	236,088	33,464	743,157
1957	515,096	235,123	93,327	843,546
1958	512,427	241,055	94,377	847,859
1959*	418,220	278,204	142,970	839,394

* Subject to revision.

(1) Sulphur content of pyrite and pyrrhotite shipped by producers. The figures for 1922-55 include the sulphur content of the acid made by roasting zinc-sulphide concentrate at Arvida, Quebec.

(2) Sulphur in liquid sulphur dioxide and sulphuric acid from the smelting of metal-sulphide ores. The figure for 1956 and the years following include sulphur in acid made from roasting zinc-sulphide concentrate at Arvida.

(3) Elemental sulphur produced from natural gas. The figures for 1952 to 1956 refer to production. From 1957 on, the figures refer to sales. The figures from 1957 include some elemental sulphur derived from the treatment of nickel-copper sulphide matte at Port Colborne, Ontario.

Consumption of elemental sulphur in Canada in 1959 was estimated at about 500,000 short tons; United States consumption is only of the order of 5 million tons a year and total world trade, excluding that from Mexico to the United States, is about 2½ million short tons.

Sulphur Production

In 1959 indigenous supplies of sulphur in all forms are officially reported as 839,394 short tons, 1% less than in the preceding year when supplies were the highest on record. This level of supplies is not identical with production, as it represents the tonnage of pyrite, pyrrhotite and recovered elemental sulphur (excluding that from oil refineries) shipped to consumers and the sulphur equivalent of sulphuric acid and liquid SO_2 derived from metal smelter gases.

In view of the very large quantities of pyritic tailings produced by non-ferrous ore mines, a large proportion of which is not commercial grade, it is not practicable to specify actual pyrite production; in the case of recovered elemental sulphur it is, and actual brimstone production in Canada based on recovery from various sources during the past five years was as shown in the table on Page 2.

On this basis and including the quantities of sulphur recovered at oil refineries and in the form of ammonium sulphate recovered by Sherritt Gordon Mines Limited, estimated in 1959 at 25,000 short tons sulphur concentrate, which is virtually identical with shipments,

Brimstone Production
(Short Tons)

	1956	1957	1958	1959	1960 (estimated)
From natural gas					
Alberta	33,500	100,700	122,300	238,600	375,000
British Columbia ...	—	4,300	62,600	53,700	70,000
Saskatchewan	—	—	500	700	900
From oil refineries ...	—	—	22,000	32,000	32,000
From metal sulphides* ...	3,000	2,400	2,500	2,500	10,000
Total	**26,500**	**107,400**	**209,900**	**327,500**	**487,900**

* Estimates of brimstone produced by various processes.

it is possible to present a truer picture of Canada's sulphur balance.

It is estimated that at the start of 1961 brimstone stocks in Canada—represented by those at natural gas treatment plants—totalled 435,000 short tons.

Recovered Sulphur

The additions to sulphur recovery capacity in 1959 represent the start of major expansion in Western Canada's natural gas industry. Production results for 1959 do not reflect fully the capacity available for production, partly because the larger plants came on stream in the course of the year but primarily—and this applies to the 1960 results as well—because the volume of clean natural gas deliveries is still at a relatively early stage of growth. It is also relevant in this respect that gas producers have tended to make use of less sulphurous wells when they had a practical and not economically adverse choice, in order to minimise the need for extracting and producing sulphur. This tendency can be expected to continue for at least two years.

Output of recovered sulphur in Alberta in 1959 rose 95% to 238,600 short tons and in 1960 it is expected further to increase by nearly 60% to 375,000 short tons. In British Columbia, sulphur production in 1959 actually receded 14% to 53,700 short tons. It is believed that Jefferson Lake Petrochemicals of Canada Limited, operating a plant at Taylor Flats in the Fort St. John sulphur area and treating gas for the West Coast Transmission Company, endeavour to keep production of sulphur as low as possible. This is also reflected by the results for 1960 when it is expected that 70,000 short tons brimstone will be produced, and in consequence the company's stocks at the start of 1961 are not likely to exceed 75,000 short tons.

Important additions to gas treatment and sulphur recovery plant capacity in Western Canada were made in 1959 by British American Oil Company, which extended its plant at Pincher Creek, Texas Gulf Sulphur Company, which brought a new plant on stream at Okotoks—the second largest in Western Canada to date—and Standard Oil Company of California, which started operations at Nevis.

Plants producing and under construction at the end of 1959 were as shown in the table on Page 3.

In addition to the above sulphur recovery capacity of 800,000 short tons in operation, construction of additional plants with an aggregate capacity of 2,373,000 short tons was proposed or under consideration early in 1960.

This picture is constantly being amended and extended as plant projects mature.

New Sulphur Producing Plants

Shell Oil of Canada is to build a $20 million gas processing and sulphur recovery

	Production			Shipments			Stocks
	Short Tons			Short Tons			
	Recovered Brimstone	Other	Total	Recovered Brimstone	Other	Total	Changes in Brimstone
1957	107,400	770,219	877,619	93,327	770,219	813,546	+ 14,000
1958	209,900	778,482	988,382	116,377	778,482	894,859	+ 90,500
1959	327,500	721,424	1,048,924	174,970	721,424	896,394	+149,000
1960*	487,900	675,000	1,162,900	307,000	675,000	982,000	+175,000

* Estimated

Sulphur Plants

Company	Location	Approximate Percentage H_2S	Capacity (short tons) Daily	Capacity (short tons) Annual*
PRODUCING				
British American Oil Company Limited	Pincher Creek, Alta.	10	755	264,000
Jefferson Lake Petro-chemicals of Canada Limited	Taylor Flats, B.C.	3	330	115,000
Texas Gulf Sulphur Company	Okotoks, Alta.	35	415	145,000
Shell Oil Company of Canada Limited	Jumping Pound, Alta.	3	100	35,000
Royalite Oil Company Limited	Turner Valley, Alta.	4	30	10,500
Imperial Oil Limited	Redwater, Alta.	10	10	3,500
Steelman Gas Limited	Steeman, Sask.	1	7	2,450
Standard Oil of California	Nevis, Alta.	6	116	40,000
Total			**1,763**	**615,450**
Cumulative Total			**1,763**	**615,450**
UNDER CONSTRUCTION				
British American Oil Company Limited	Homeglen-Rimbey, Alta.	4-8	280	98,000
The Canadian Oil Companies Limited	Innisfail, Alta.	30	123	43,000
British American Oil Company Limited	Nevis, Alta.	6	111	39,000
Total			**514**	**180,000**
Cumulative Total			**2,277**	**795,450**
PLANTS PROPOSED (not dependent on gas export.)				
Imperial Oil Limited	Joffre, Alta.	13	110	38,000
Shell Oil Company of Canada Limited or Hudson's Bay Oil and Gas Company Limited	Olds, Alta.	10	110	38,000
Mobil Oil Company or British American Oil Company Limited	Wimborne, Alta.	30	390	136,000
			610	**212,000**
ADDITIONAL PLANTS necesssary for large-scale gas exports				
British American Oil Company of Canada Limited, or Shell Oil Company of Canada Limited	Berland River.	35	840	292,000
Texaco Exploration Company	Castle River, Alta.	30	560	196,000
	Central Foothills, Alta.	5	220	77,000
Jefferson Lake Petro-chemicals of Canada Limited	East Calgary, Alta.	35	900	312,000
	Savanna Creek, Alta.	15	670	234,000
Shell Oil Company of Canada Limited	Waterton Park, Alta.	30	1,500	525,000
Canadian Fina Oil Company Limited, Hudson's Bay Oil and Gas Company Limited, Pan American Oil and Gas Company Limited	Whitecourt, Alta.	18	1,500	525,000
Total			**6,190**	**2,161,000**
Cumulative Total			**6,800**	**2,373,000**

*** On the basis of 350 days' operation a year.**

plant in the Pincher Creek area of Southern Alberta, which is due to be completed in late 1961. Initially it will produce 100 million cu. ft. of processed gas a day for the Alberta and Southern Gas Company for export to the United States. At the same time it will produce daily 1,000 tons of brimstone and between 3,500 and 4,000 barrels of liquid petroleum products.

Mobil Oil Company, in conjunction with other interests, is considering the construction of a 30 million cu. ft. a day gas processing plant in the Wimborne area of Alberta. Costing $3,750,000, the unit is to produce 140 tons of brimstone and 100 barrels of stabilised petrol a day.

Jefferson Lake Petrochemicals of Canada Limited proposes to build a gas gathering system and gas processing plant to serve the Calgary gas field of Alberta. To cost $12 million, the plant would handle 150 million cu.

ft. of gas daily and would produce 863 long tons of sulphur daily. Westcoast Transmission Company has contracted to buy the gas for export to the Pacific Northwest Pipeline Corporation in the U.S.A. It is probable that the plant will not be built before 1962. The project has to tie-in with the completion of export pipelines and the Alberta trunk foothills pipeline system, which are not due for completion till the autumn of 1962.

Construction of a $35 million gas processing and sulphur manufacturing plant a few miles north-east of Calgary, Alberta, has begun. H. W. Manley, vice-president of Jefferson Lake Petrochemical Company and A. O. Detiner, president of Mobil Oil of Canada Limited, said recently that the plant will produce annually 285,000 tons of sulphur, 700,000 barrels of condensate and 36,000 million cu. ft. of gas.

Natural Gas Developments

In March 1960 the National Energy Board of Canada issued a report on the application of six companies, Trans-Canada Pipelines Limited, Alberta and Southern Gas Company, Alberta Natural Gas Company, Westcoast Transmission Company, Canadian Montana Pipe Line Company, and Niagara Gas Transmission Limited, to construct and operate pipelines for the transmission of gas to be exported to the U.S.A. All the applications were granted subject to conditions about the quantity of gas; only that of Niagara Gas was deferred, the company's revised application being accepted on 8 June 1960.

Sulphur Reserves

In its report the Board estimates the established reserves of natural gas at 31 December 1959 to have been 29 trillion (10^{12}) cu. ft., containing about 106,000,000 tons of sulphur. The board believes that development of further reserves can be expected at an average rate of 2.5 trillion cu. ft. a year for at least the next 10 years, and after that on a somewhat decreasing scale. By 1989 the disposable reserves are expected to be about 92 trillion cu. ft., equivalent to 326,000,000 tons of sulphur.

Approval has been granted by all the authorities concerned for the construction of the Alberta-California pipeline. The two Canadian authorities concerned, the Alberta Provincial Government and the Government of Canada, gave their permission early in 1960 and the project was held up till the autumn when the U.S. Federal Power Commission and

Shell Oil gas recovery plant, Jumping Pound, Alberta. Heater converters of sulphur plant *(far left). Left centre* **boiler house with five stacks rising in the background.** *Right* **processing towers which recover natural gasoline and prepare natural gas for industrial and domestic use**

the California Public Utilities Commission gave their consent.

Total length of the pipeline will be a little over 1,400 miles and the total cost is estimated at about $400 million. Starting at the Berland River gas field in the eastern foothills of the Rockies, west-north-west of Edmonton, the pipelines will run through southern Alberta, across the south-east corner of British Columbia, through the Idaho Panhandle, across the south-east corner of Washington, through central Oregon and into California. The terminal will be at Antioch, to the north of San Francisco.

New Natural Gas Sources

New sources of sour natural gas continue to be found in Alberta. In 1959 discoveries included Burnt Timber Creek by Shell Oil of Canada, Lookout Butte by the British American Oil Company and Wildcat Hills by Imperial Oil Limited and Western Leaseholds Limited.

In the Panther River, Alberta, area Texas Gulf has plans to develop what is believed to be the area with gas of the highest known sulphur content (87% H_2S.). It is suggested in the Department of Mines' report, however, that the development will not take place until sulphur demand rises and markets are more predictable.

Oil Refineries and Sulphur Recovery

In 1959, the first full year of operation, Laurentide Chemicals and Sulphur Limited produced 32,000 short tons of elemental sulphur from refinery gas with H_2S content varying from 2% to 12% extracted from sour crude oils at a number of refineries in the neighbourhood of Laurentide's Montreal East plant.

An oil refinery under construction by Irving Refinery Limited at Saint John, New Brunswick, includes provision for the recovery of elemental sulphur. In recent months several major oil refineries in Canada have announced the installation of desulphurization plant. None, however, will for the time being recover sulphur. The potential for sulphur recovery from refineries in Canada is for the present limited, mainly because the bulk of United States and Canadian crudes are sweet or low sulphurous, and only imported Middle East crudes contain sulphur.

Pyrite and Pyrrhotite

Despite the ever-increasing amounts of sulphur produced from natural gas and the plentiful supplies available from the Frasch sulphur producers, pyrites and pyrrhotite still remain important sources of sulphur in Canada.

In 1959 shipments from mines totalled 1,051,873 short tons, 11.7% less than in 1958. Due to greater quantities of pyrrhotite being supplied the average sulphur content of deliveries is reported to have declined from 43% S to 39.8% S, with the result that the tonnage of sulphur in pyrites—418,220 short tons in 1959—was 18.3% lower than in 1958.

The companies shown below produce pyrite and pyrrhotite for their own use, for domestic sales or exports.

Howe Sound Company resumed operations in 1959 but two producers ceased operating. Lorado Uranium Mines Ltd., who had used pyrite captively for acid manufacture, started using other sources of sulphur during 1959. Weedon Pyrite and Copper Corporation, which sold its pyrite output at home and abroad, closed down during the year because of limited ore reserves.

Transport costs and the value of the iron residues are the determining factors whether or not pyrite is competitive with imported Frasch sulphur and indigenous recovered sulphur.

Producers of Pyrite and Pyrrhotite Concentrates

Company	Location	Disposal
Consolidated Mining and Smelting Company of Canada Limited	Kimberley, B.C.	Captive use and for sale
Howe Sound Company	Britannia Beach, B.C.	Sale
International Nickel Company of Canada Limited	Copper Cliff, Ont.	Captive use
Noranda Mines Limited	Noranda, Que.	Captive use and for sale
Waite Amulet Mines Limited	Noranda, Que.	
Quemont Mining Corporation Limited	Noranda, Que.	Sale
Normetal Mining Corporation Limited	Normetal, Que.	Sale

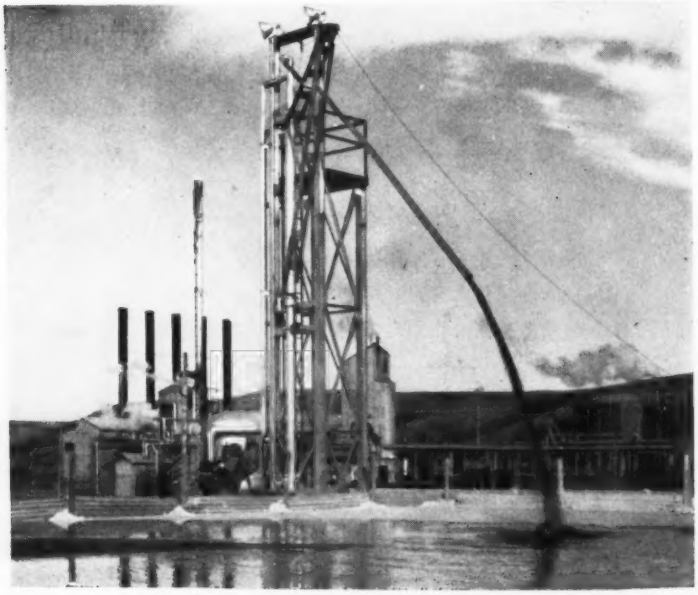
The decline of pyrite shipments in 1959 is attributable mainly to the lower exports. Exports of pyrite to the U.S.A. declined in value by 33% and those to Europe by 68%. The latter were confined to U.K. at a level 40% lower than in 1958, while the West German market was lost.

It is estimated that of 1.05 million short tons (418,220 short tons only of equivalent) pyrite and pyrrhotite shipped in 1959 approximately 350,000 short tons was exported and about 700,000 short tons, including all the lower grade pyrrhotite, delivered to domestic consumers. The sulphur equivalent of domestic delivery appears to be about 40,000 tons lower than in 1958. In 1960 the reduced sulphuric acid demand of the uranium industry, a large section of which receives its acid supplies from the two pyrite-based acid plants of Noranda Limited at Cutler, Ontario, severely reduced pyrite shipments and it is estimated that they receded to 350,000 short tons sulphur equivalent.

Smelter Gas

Smelter gas resulting from roasting of sulphide ore, notably copper and nickel ores, serves as a major source of sulphur dioxide for sulphuric acid manufacture. In 1959 output of by-product sulphuric acid and liquid SO_2 from smelter gases increased to 278,204 short tons sulphur equivalent, an increase of about 37,000 short tons (15.5%) over 1958. The output is valued at $9.78 per short ton sulphur equivalent, and originates from the Trail plant of the Consolidated Mining and Smelting Company and the Copper Cliff Plant of the International Nickel Company, the sulphuric acid being manufactured by Canadian Industries Limited. This company also produces liquid sulphur for sale to pulp mills, which is derived from the concentrated SO_2 gas of International Nickel's flash smelter. It is estimated that about 80,000 short tons liquid SO_2 was produced in 1959.

Under construction by Sherbrooke Metallurgical Company (see Current Events) was a by-product sulphuric acid plant at Port Maitland, Ontario which, from SO_2 in smelter gases, is to produce approximately 140,000 short tons (100% H_2SO_4) sulphuric acid. Plans were also announced late in 1959 by Border Chemical Company of Winnipeg to build a 50 ton per day contact sulphuric acid plant based on SO_2 from nickel copper sulphides at Transcone, Manitoba. This plant will be the only commercial producer of sulphuric acid between Sudbury, Ontario, and Fort Saskatchewan.



Sulphur extraction plant at Jumping Pond, Alberta. Liquid sulphur being poured into vats at Shell Oil Company of Canada's sulphur extraction unit at Jumping Pound Alberta. When the vat is filled its walls are removed, leaving the huge block of elemental sulphur which is consequently broken up for shipment to pulp and paper producers on the Pacific coast

Alberta, and will provide acid prices lower than those for imported acid. While the metal smelter is being built acid will be manufactured from recovered brimstone. Both plants are now on stream and are expected to raise the sulphur equivalent of acid produced from smelter gases by 50,000 short tons a year.

Sulphide Ores

In 1959 elemental sulphur was produced from sulphide ores at International Nickel's Copper Cliff plant, where sulphur dioxide roaster gas is used to produce elemental sulphur in a pilot plant operated by Texas Gulf Sulphur Company. Output is small and limited to experimental work. A commercial scale process is used at International Nickel's Port Colborne refinery*, where high purity elemental sulphur is produced by the electrolysis of nickel sulphide matte. Although installed capacity is 100 tons brimstone per day it is estimated that only about 10,000 tons sulphur was recovered in this way in 1960. Noranda Mines Limited ceased operations at its Port Robinson plant as recovery of elemental sulphur from pyrite no longer proved economical or competitive with other sources of sulphur supply.

Brimstone Imports

Whereas indigenous recovered brimstone has replaced imported Frasch sulphur in Western Canada, brimstone demand in Eastern Canada continues to be met almost exclusively by imports.

In 1959 these totalled 332,430 short tons, a decline of 43,000 short tons (11.4%) compared with the preceding year.

U.S. Frasch sulphur accounted for the bulk of imports, although Mexico increased its share of the market from 1,130 short tons in 1958 to 4,815 short tons in 1959. The value of imports declined from Can. $22.20 in 1958 to Can. $20.80 per short ton in 1959.

In 1959 brimstone exports totalled 26,526 short tons destined wholly for the U.S.A. In 1960 the rate of exports rose sharply and it is estimated that about 150,000 short tons has been shipped to the U.S.A.

Brimstone Consumption

It is estimated that total brimstone consumption in 1959 was similar to that in 1958, when 515,047 short tons was used.

Sulphur—Imports & Exports, 1949-59
(short tons)

Imports	Exports	
Brimstone	In Pyrite (1)	Other Sulphur (2)
280,557	90,553	—
390,333	111,652	65
395,928	178,039	44
415,185	197,897	—
359,205	129,608	4,633
310,127	188,608	3,339
373,373	$2,001,575	3,051
474,117	$2,649,349	4,331
416,930	$2,852,753	12,364
375,331	$1,879,251	7,608
332,430	$1,018,608	26,526

(1) Exports of pyrite, sulphur content. The quantities for 1955 and the years following are not available, only the values are published.
(2) Exports of sulphur produced from natural gas and other sources.

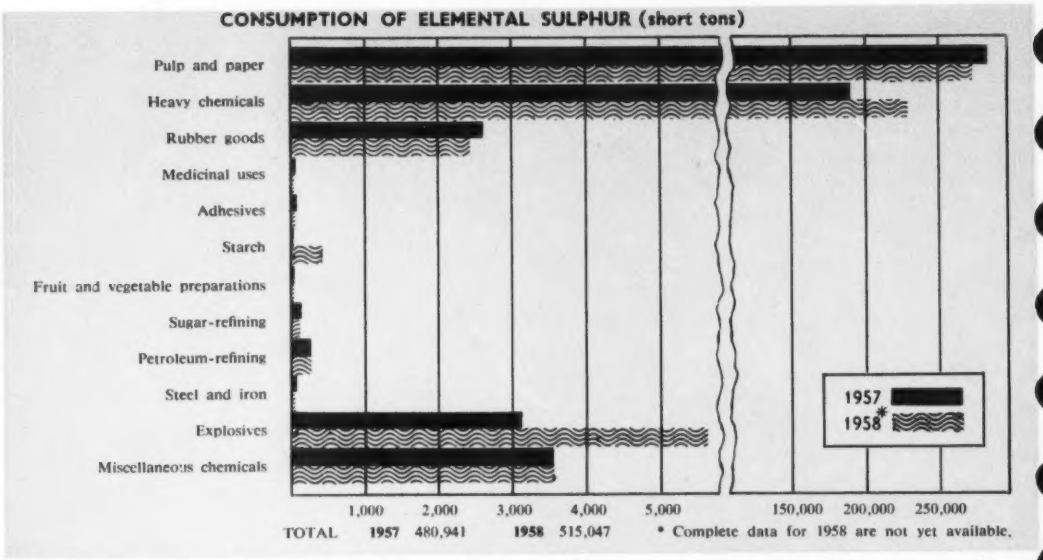
Consumption in Canada in 1959 of sulphur in all forms is estimated at about 1.07 million short tons represented by sulphur in pyrites shipped to the domestic market, sulphur in smelter gases, indigenous recovered brimstone from natural gas, oil refinery gases and sulphide ores, imported brimstone and sulphur in by-product ammonium sulphate. Compared with 1958 lower consumption of pyrites seems to have been compensated by greater consumption of by-product sulphuric acid from smelter gases and against lower brimstone imports, the use of indigenous recovered sulphur increased. In 1960 total consumption appears to have receded to just over 1 million short tons sulphur as the result of lower pyrites acid demand by the uranium industry.

No significant change in this picture is anticipated for 1960. Activity in the pulp industry improved, but other industries, notably steel, automobiles and some sectors of the

Consumption of Elemental Sulphur
(short tons)

	1958	1957
Pulp and paper	273,861	284,561
Heavy chemicals	229,170	189,911
Rubber goods	2,424	2,687
Medicinal uses	21	43
Adhesives	61	77
Starch	450	43
Fruit and vegetable preparations	3	6
Sugar-refining	135	144
Petroleum-refining	225	225
Steel and iron	58	83
Explosives	5,374	3,161
Miscellaneous chemicals	3,265	—
Total	**515,047**	**480,941**

* See SULPHUR 20, Page 45.



chemicals industry, failed to maintain their level of activity of 1959.

Sulphuric Acid

Production and Trade. Production of sulphuric acid in Canada in 1959 was 1,610,000 short tons, an increase of 115,000 short tons (7½%) compared with that in 1958 and the highest on record.

It is estimated that 40% of total Canadian sulphuric acid production is based on SO_2 in smelter gases and 30% each on brimstone and pyrites.

Exports of sulphuric acid have remained fairly steady for many years, but imports after being very low (never more than 2,100 short tons) suddenly rose to 39,345 short tons in 1958, dropping back to 18,489 short tons in 1959 as new domestic plants were able to satisfy the increased demand.

Consumption. Apparent consumption was 1,600, 626 short tons, 110,500 short tons (6%) more than in 1958.

The apparent consumption figures do not agree with actual sulphuric acid consumption which for 1958 is reported at 1,675,000 short tons, a discrepancy of 164,000 short tons. For previous years also apparent consumption is lower than reported actual consumption and the discrepancy is believed to be due to the incompleteness of the figures relating to acid produced and consumed for uranium processing. The Department of Mines and Technical Surveys has introduced new procedures which it is believed will provide more accurate data in the future.

Production, Trade and Apparent Consumption of Sulphuric Acid, 1949-59
(short tons of 100% acid)

	Production	Imports	Exports	Apparent Consumption	Reported Actual Consumption
1949	707,717	24	17,336	690,405	692,000
1950	756,110	332	44,417	712,025	728,500
1951	820,867	1,162	57,000	765,029	768,698
1952	816,270	85	33,135	783,220	790,100
1953	822,608	70	47,889	774,789	797,400
1954	923,800	110	21,930	901,980	922,500
1955	950,277	151	29,578	920,850	937,800
1956	1,052,000	2,100	23,660	1,030,440	994,800
1957	1,290,000	1,046	29,550	1,261,496	1,654,100
1958	1,495,000	39,345	23,252	1,511,093	1,675,600
1959*	1,610,000	18,489	27,863	1,600,626	n.a.

* Subject to revision

The fertilizer and uranium industries are the largest users of sulphuric acid, accounting for well over two-thirds of production. As stated above, the amount of sulphuric acid used for uranium processing is not accurately known, but the following is thought to be a reliable estimate:—

Sulphuric Acid Consumption in Uranium Processing
(short tons)

Year	H_2SO_4 consumed
1957	567,000
1958	586,700
1959	619,600
1960	Estimated less than 400,000

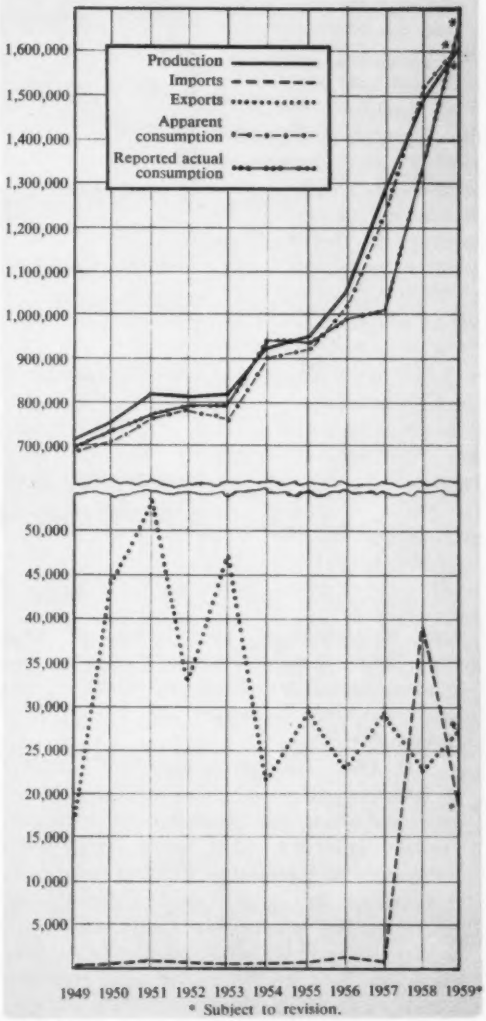
The outlook for uranium producers in Canada at present is not favourable. Nevertheless in November 1960 Rio Tinto increased its equity holding in Rio Tinto Mining Company of Canada from 54% to 80%, which virtually represents an increase in Rio Tinto's Canadian uranium stake. The price paid for the shares is thought to have been less than the prevailing market price in Toronto and the acquisition should be profitable on the basis of existing Government uranium contracts.

It is estimated that consumption in 1959 was slightly higher than in 1958 but in 1960, because of the decline in uranium processing, it is unlikely to have exceeded 1.5 million short tons. The main effect of this reduction will have been on acid produced from pyrites, whereas by-product sulphuric acid from smelter gases and brimstone acid are likely to have advanced.

Consumption of Sulphuric Acid
(short tons of 100% acid)

	1958	1957
Fertilizers	673,000	668,900
Acids, alkalis and salts	176,300	177,900
Nonferrous smelter & refiners	31,500	29,300
Coke and gas	27,500	28,000
Petroleum-refining	16,300	11,100
Leather-tanning	2,200	2,100
Iron and steel	37,300	31,900
Electrical apparatus	8,600	8,400
Plastics	17,800	16,600
Soap and washing compounds	14,300	13,700
Sugar refining	300	300
Pulp and paper	15,300	12,400
Vegetable oils	100	100
Adhesives	700	900
Miscellaneous	68,100	85,500
Uranium ore processing	586,700	567,000
Total	**1,675,600**	**1,654,100**

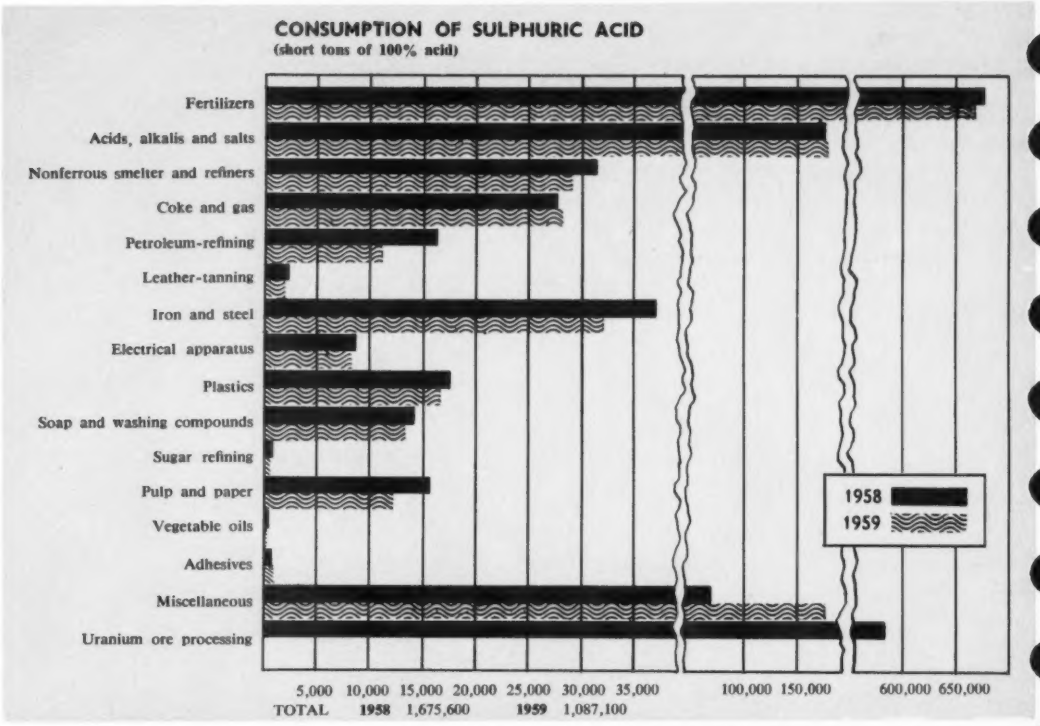
SULPHURIC ACID
Production, Trade and Apparent Consumption, 1949-59
(short tons of 100% acid)



* Subject to revision.

Outlook

Canada is today the sixth largest consumer of sulphur in the world, and at over one million short tons *per capita* consumption is about 118lb., the highest in the world. Rising demand for wood pulp and expansion of her industries, notably chemicals, points to progressively greater sulphur needs. The pressures on her economy which is strongly influenced by the economic climate in the U.S.A. and the



rate of population growth and of capital investment, however, mitigate against steady expansion and the past years' record of booms and recessions is unlikely to change in the foreseeable future.

In 1961 the general economy is expected to improve and of her main sulphur users, the pulp and chemicals industries are expected to expand activities, also to a lesser extent fertilizers and metallurgy. Sulphur consumption is expected to rise 5% to 7% divided about equally between increased availability and use of by-product sulphuric acid from smelter gases and greater brimstone use; pyrites are unlikely to make headway.

Three new projects are due to make an impact before 1962. Continental Titanium Corporation of Toronto is to start manufacturing titanium oxide pigments by a new process claimed to permit a 30% reduction of costs. Details have not yet been released but the process is described as a continuous pressure-leaching technique adapted to Quebec ores. Output is expected at a rate of 20 short tons per day pigment which is expected to require 2.9 short tons sulphuric acid per short ton of product. A $2 million plant using the new technique is planned by the company on a site 60 miles East of Quebec City. British Titan Products started construction of a 20,000 tons TiO_2 pigment plant at Tracy, Quebec. A Brimstone acid plant—probably with a capacity of 75,000-80,000 tons a year (100% H_2SO_4)—will be included in the project.

Electric Reduction Company is due to bring on stream a $12 million plant at Port Maitland, Ontario, for the production of phosphoric acid, triple superphosphate, phosphatic fertilizer solution and industrial phosphates. By - product sulphuric acid from Sherbrooke Metallurgical Company (see above) will meet the new plants needs.

The large quantities of brimstone recovered from natural gas which are becoming available in Western Canada are raising severe marketing problems. At present consumers in Eastern provinces of Canada find it more economic to satisfy their brimstone requirements by imports of Frasch sulphur from the U.S.A. and Mexico, and in favourable locations they can draw on

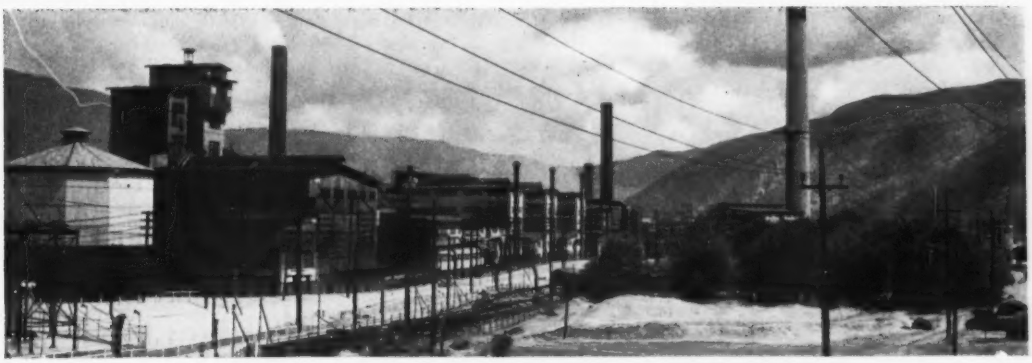
supplies of low cost pyrites or by-product sulphuric acid and liquid SO_2. Thus, both distance and limitation of size preclude Eastern Canada representing an outlet for the growing volume of West Canadian sulphur.

Alberta, the largest natural gas producing area, is not well served by railways, there being virtually only two lines, part of the main East-West system, running across the State. It was hoped that the Canadian railways would offer preferential rates as the volume of sulphur shipments grew, but this does not now seem likely, as the railway companies are making efforts to raise tariffs generally and eliminate preferential tariffs from their systems.

The possibility has been mooted and research work initiated on transporting the elemental sulphur in the form of a slurry in water to Vancouver or elsewhere on the Pacific west coast. Piping the sour gas direct to the major sulphur markets in the Great Lakes area of U.S.A. and other parts of Canada and recovery of the sulphur where it is to be used has also been suggested. Here the corrosion problems, always present with long-distance pipelines, are made even greater by the corrosive nature of the sulphur compounds.

Both alternatives are being investigated by Pembina Pipeline Limited which is reported to have developed a project for a pipeline to the U.S.A. Midwest and to the Great Lakes areas which would also carry liquid petroleum gases.

The accelerating build-up of stocks increases the producers' urgency to find markets even though at present costs of production and transport, profit margins would be slender. During the next two years, Jefferson Lake Petrochemicals of Canada can be expected to become prominent among West Canadian sulphur producers, and as the parent company's interests in its Frasch sulphur operations decline, emphasis on profitable marketing from its subsidiary's new production facilities will assume increasing importance. Similarly Shell Oil Company and British American Oil Company are unlikely to be willing to defer driving for markets. Only Texas Gulf Sulphur Company can be said to have an interest in preventing its Canadian Sulphur from aggravating pressure on the U.S. and world markets, although it cannot be overlooked that at present the Great Lakes area is not one of the company's main spheres of interest and its interest in the Sulphur Export Corporation is only 37.5%. Vancouver, as an export port for sulphur, enjoys a freight advantage over Gulf ports and up to $3 to the Far East, India and Australasia; to Europe, Africa and the Near East, however, freight charges at present are up to $3 higher. The key to Canada's marketing problems could be Japan, if the economic disincentive of abandoning indigenous pyrite—a large employer of labour and a reasonably profitable and well-integrated industry—were to be outweighed by a major increase of reciprocal trade with Canada. Rising world demand for sulphur in which China's expanding economy could well play a major part offers an obvious solution in the longer term, but from 1962 to 1965 Canada's marketing problem will prove to be a burden to the entire world sulphur industry.



Acid plants of Consolidated Mining & Smelting Company, Trail, B.C.

Sulphurous Materials Situation in O.E.E.C. Countries and the U.S.

PRODUCTION of sulphurous materials in Western Europe showed an 8% rise to 4,000,000 tons in 1959 (excluding Spain), compared with the previous year. This is indicated in the latest survey of the sulphurous materials situation for O.E.E.C. countries and the U.S. and contained in the latest report of the O.E.E.C.'s Chemical Products Committee Secretariat.

The marked expansion of output is due to sulphur from the Lacq natural gas; otherwise, state O.E.E.C., the situation would have been rather less favourable than in the previous year. French production of sulphur from Lacq natural gas rose from 132,000 tons in 1958 to 437,000 tons in 1959.

Consumption

Consumption of sulphurous materials for the manufacture of sulphuric acid amounted to 4.4 million tons in 1959 and total consumption for all purposes is estimated at rather more

Production of Sulphur in all forms in 1959

In thousand metric tons of sulphur content

	Native Sulphur	Sulphur as such obtained by chemical processes or recovered	Pyrites	Zinc Blendes	Anhydrite*	Spent Oxide	Total
	1	2	3	4	5	6	7
Austria	—	0.4	0.3	3.6	20.4	0.8	25.5
B.L.E.U.	—	—	—	—	—	2.6	2.6
Denmark	—	—	—	—	—	—	—
France	—	437.0	124.2	8.7	—	6.0	575.9
Germany	—	79.7	190.9	—	—	—	270.6
Greece†	3.5	—	129.6	8.6	3.6	0.1	145.4
Ireland	—	—	1.7	0.4	—	—	2.1
Italy	235.0‡	4.0	680.0	38.0	—	6.0	963.0
Netherlands ...	—	31.2	—	—	—	1.3	32.5
Norway	—	78.4	188.5	6.5	—	—	273.4
Portugal	16.0	—	291.0	—	—	—	307.0
Spain	3.1	26.1	744.3	5.0	—	—	778.5
Sweden	—	38.2	173.7	39.8	—	—	251.7
Switzerland ...	—	—	—	—	—	1.3	1.3
Turkey	12.8	—	32.6	—	—	—	45.4
United Kingdom ...	—	54.0	—	—	159.1	103.0	316.1
Total	**270.4**	**749.0**	**2,556.8**	**110.6**	**183.1**	**121.1**	**3,991.0**
United States ...	4,626.7	661.2	(406.4)	(325.1)	—	101.6	6,121.0

* Relate to sulphuric acid only
† Figures for 1957
‡ Including mining waste

Raw materials used for the Manufacture of Sulphuric Acid in 1959

	Sulphur as such	Pyrites	Zinc Blendes	Anhydrite	Spent Oxide	Total
	1	2	3	4	5	6
Austria	13.9	2.2	7.0	20.4	1.2	44.7
B.L.E.U.	123.3	158.2	149.2	—	2.6	433.3
Denmark	2.5	64.9	—	n.a.	n.a.	67.4
France	182.0	357.5	63.5	—	27.0	648.7*
Germany	(55.0)	(680.0)	n.a.	—	3.2	(738.2)
Ireland	—	—	—	—	—	—
Italy	81.9	655.7	20.0	—	6.0	736.6
Netherlands	85.0	163.0	15.7	—	1.3	265.0
Norway	0.3	15.8	18.9	—	—	35.0
Portugal	—	146.0	—	—	—	146.0
Spain	1.5	222.4	n.a.	—	—	(223.9)
Sweden	5.8	121.1	—	—	—	126.9
Switzerland	28.6	14.3	—	—	—	42.9
United Kingdom	385.7	155.7	59.2	159.6	108.2	868.4
Total	**965.5**	**2,756.8**	**333.5**	**180.0**	**149.5**	**4,404.0**
United States	3,896.6	548.7	325.1	—	101.6	4,872.0

* Including the equivalent of 18,700 tons of sulphur in H_2S

than 5,000,000 tons. Compared with previous years, the level of consumption has not altered appreciably. Should it not soon move upwards, European producers may be forced to look more and more to overseas countries in order to dispose of their total output, the report states.

Between 10% and 20% of total consumption of sulphurous materials in Western Europe is reported to be used for purposes other than the manufacture of sulphuric acid. As the tonnage does not vary appreciably from year to year O.E.E.C. are no longer collecting statistics, hence non-acid uses of sulphur are not specified, and reference is made in the O.E.E.C. report to the statistical picture in 1958. The British Sulphur Corporation's estimate for non-acid uses of sulphur in O.E.E.C. countries is 17%-18% for carbon disulphide. In a number of instances the O.E.E.C. statistics which represent data supplied to this organisation by the appropriate member countries are unfortunately incomplete and not up to date.

$Al_2(SO_4)_3$ Production from Coal Mine Waste

PRODUCTION of high purity aluminium sulphate is the first step in a new process developed to the pilot plant stage by North American Coal Corporation of Cleveland, Ohio, in co-operation with Strategic Materials Corporation. The process is to be used in a new 40,000-ton a year plant costing over $1 million. It will be the first of its kind to produce high purity aluminium sulphate from mine wastes. Production of $Al_2(SO_4)_3$ is the first step for obtaining high purity aluminium oxide from coal mine wastes, shales or other raw materials such as clays or bauxite.

In the new process mine waste material having the following analysis

Al_2O_3	15 - 23%
SiO_2	34 - 55%
Fe	7.5 - 3%
CaO	1.3 - 0.7%
MgO	0.5 - 0.8%
Na_2O	2.0 - 2.8%
TiO_2	0.6 - 1.0%
S	7.9 - 3.0%
C	25 - 5.0%

is reacted with sulphuric acid. This converts the aluminium and iron to soluble sulphates. Silica and other impurities are separated by filtration and pure aluminium sulphate is recovered. To produce aluminium oxide, the aluminium sulphate is thermally decomposed to yield the metal oxide and the acid values are recycled in the process. The net acid per ton of waste varies with a number of factors, but a close approximation can be made by considering the stoichiometric quantities needed for the formation of aluminium sulphate and for reaction with alkaline impurities. Conversion of aluminium sulphate to aluminium oxide involves a thermal decomposition of the sulphate and recycle of the acid values without using a conventional contact acid plant. About 90% of the Al_2O_3 is extracted.

North American Coal Corporation's Process

Significance of the process to the U.S. metal industry is the potential development of a domestic source of alumina for the manufacture of aluminium. U.S. crude bauxite output in 1959 was 1.7 million tons while imports of the material for U.S. consumption were more than eight million tons. North American Coal Corporation now produces over 500,000 tons of mine waste from its Powhatan mine on the Ohio River. At an average analysis of 20% alumina, this would mean 100,000 tons of alumina or 50,000 tons of aluminium metal a year. Potential output, however, is much higher since there are extensive reserves of both coal and shale. Also, low cost electric power is available from power plants using coal from the company's mines which also yield the shale for the alumina.

The plant is now being engineered at Powhatan and is due to be completed in August this year (1961). Part of this plant's output will be aluminium sulphate for the commercial market and part will be used on a captive basis for large scale studies of the decomposition to aluminium oxide. Sulphuric acid requirements of this plant will be obtained from the commercial market.

Healthy Revival of Japan's Sulphuric Acid Industry

AFTER the recession and industrial difficulties experienced in 1958, recovery of Japan's economy became evident in the first half of 1959 and has since developed into a sustained industrial boom. In the first half of 1960 all sectors of Japanese industry continued to make great strides with the exception of the nitrogenous fertilizer industry, where a deliberate policy of rationalization was being pursued. This is reflected by the results of the sulphuric acid industry.

Quantitatively, the most important increases in sulphuric acid consumption were those for phosphatic fertilizers, followed in turn by man-made and synthetic fibres, inorganic chemicals, and iron and steel, thus maintaining the trend noted in the first half of 1959. The greatest relative increases in acid use were shown by oil and fat, reflecting the rapid expansion of Japan's detergent industry, dyestuffs and intermediates, paper and pulp and activated clay, due to the demand arising from the country's oil refineries, and metallurgy.

Overall consumption of sulphurous raw materials increased by 5.5% by weight of materials.

Particularly marked is the increased use of copper concentrates (+14.5%) and zinc blende (+13.8%). Use of iron pyrites (4%) has continued to rise although not as much as in the corresponding period of 1959. For the first time since 1957 use of sulphur ore has increased very slightly (+0.2%).

Sulphuric Acid Consumption

	Jan.-June 1960	Change	%
Nitrogenous fertilizers ...	854,000	−136,000	−15.9
Phosphatic fertilizers ...	558,000	+ 75,000	+13.4
Artificial and synthetic fibres	264,000	+ 46,000	+17.4
Inorganic chemicals	158,000	+ 35,000	+22.4
Organic chemicals	45,000	+ 8,000	+18.3
Iron and steel	66,000	+ 13,000	+19.1
Petroleum	41,000	+ 6,000	+14.1
Dyestuffs and intermediates	30,000	+ 9,000	+29.6
Metal industry	14,000	− 6,000	− 4.3
Paper and pulp	19,000	+ 4,000	+23.6
Metallurgy	19,000	+ 5,000	+27.2
Oil and fat	14,000	+ 5,000	+34.4
Celluloid and nitrocellulose	10,000	+ 2,000	+21.5
Activated clay	11,000	+ 3,000	+27.7
Tar products	6,000	− 800	−13.9
Others	110,000	+ 20,000	+15.7
Total	**2,218,000**	**+ 84,000**	**+ 4.0**

Sulphurous Raw Materials Consumption

	Jan.-June 1960 '000 tonnes	Change tonnes	%
Iron pyrites	1,024	+42	+ 4.0
Pyrrhotite	121	+ 8	+ 6.6
Sulphur ore inc. ore which contains iron pyrites	322	+ 4	+ 0.2
Zinc blende	149	+21	+13.8
Copper ore, mainly concentrates and raw cupriferous ore ...	150	+22	+14.5
Lead ore	11	− 0.3	− 0.3
Total	**1,777**	**+96.7**	**+ 5.5**

Comparison of the consumption of copper and zinc ores with the acid actually produced

Survey of Japanese Sulphuric Acid Industry (Production) Annual Growth '000 tons 1950-1959

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Chamber	1,020	1,099	1,120	1,138	1,330	1,427	1,549	1,487	1,286	1,363
Contact	1,011	1,271	1,387	1,545	1,715	1,863	2,146	2,446	2,515	2,832
Total	**2,031**	**2,369**	**2,507**	**2,684**	**3,044**	**3,290**	**3,695**	**3,902**	**3,802**	**4,195**
% Change										
Chamber	−	+ 5.8	+ 1.9	+ 1.6	+16.8	+ 7.3	+ 8.5	− 4.0	−13.5	+ 6.0
Contact	−	+25.6	+ 9.1	+11.4	+11	+ 8.6	+15.2	+14.0	+ 2.8	+12.5
Total	−	**+16.6**	**+ 5.8**	**+ 7.0**	**+13.4**	**+ 4.8**	**+12.3**	**+ 6.4**	**− 3.3**	**+10.3**
Acid Production from Raw Material										
Pyrrhotite										
Sulphur Ores ...	1,845	2,116	2,243	2,445	2,711	2,909	3,209	3,343	3,168	3,470
Copper and Zinc ...	186	253	264	229	333	381	486	589	634	726
(Copper)	—	—	—	—	—	—	278	353	387	449
(Zinc)	—	—	—	—	—	—	208	236	247	277
% Change										
Sulphur	−	+16.5	+ 5.8	+ 7.1	+13.4	+18.1	+12.3	+ 6.4	− 3.3	+10.3
Copper and Zinc ...	−	+36	+ 4.4	−13.2	+45.5	+14.4	+27.5	+21.2	+ 7.6	+12.7
(Copper)	−	−	−	−	−	−	−	+27	+ 9.6	+16
(Zinc)	−	−	−	−	−	−	−	+13.5	+ 4.7	+12.1

New Sulphuric Acid Plants

1 April 1959 to 1 April 1960

Company	No. of Plants	Process	Type of Plant	Designed capacity 100% H_2SO_4 tonne/day
Mitsui Metal Mining Company				
Hibi Smelter	2	Contact	Monsanto	108
Nitto Sulphuric Acid and Soda Company				
Niigata Works	2	Nitration	Tower	65
Osaka Gas Company				
Hokko Works		Contact	Lurgi wet process	21
Tokyo Gas Company				
Toyosu Works		Contact	Lurgi wet process	60

Dismantled Sulphuric Acid Plants

1 April 1959 to 1 April 1960

Company	No. of Plants	Process	Type of Plant	100% H_2SO_4 tonne/day Designed capacity
Konoshima Chemical Industries Company				
Konoshima Works	1	Nitration	Chamber	28
	2	,,	,,	28
Nissan Chemical Industries Company				
Fushiki Works	1	Nitration	Tower	28
	2	,,	Chamber	52
Kagami Works	1	Nitration	Chamber	30
	2	,,	,,	53
Nagoya Works	1	Nitration	Tower	26
Toyama Works	1	Nitration	Chamber	44
Nitto Sulphuric Acid and Soda Company				
Niigata Works	2	Nitration	Chamber	41
Taki Fertilizer Manufacturing Company				
Befu Works	1	Nitration	Chamber	31
	2	,,	,,	31
Yawata Iron and Steel Company				
Yawata Works	1	Nitration	Chamber	30

from them confirms the trend noted earlier that there has been a considerable increase in efficiency in recovering the sulphur content of the smelter gas. Both quantitatively and proportionally the output from contact plants rose more than that from chamber plants which in the first half of 1960 accounted for 50% of total Japanese production. The trend towards a greater proportion of contact acid is now firmly established.

Sulphuric Acid Production

Jan.-June 1960

'000 tonnes

	Sulphur ores	Copper ores	Zinc ores	Total
Chamber	634	74	27	735
Contact	1,179	175	121	1,475
Total	**1,813**	**249**	**148**	**2,210**
Tons change				
Chamber	12	17	11	40
Contact	54	98	39	191
Total	**66**	**115**	**50**	**231**
% change				
Chamber	2	24	14	40
Contact	4.6	5.6	9.2	19.4
Total	**6.6**	**29.6**	**23.3**	**59.5**

In the year from April 1959 to April 1960, 15 chamber and two tower plants having a total design capacity of 422 tonnes a day of 100% sulphuric acid have been dismantled. In the same period five new contact plants having a total design capacity of 189 tonnes a day of 100% sulphuric acid have been installed and two tower plants of 65 tonnes a day total 100% sulphuric acid capacity; in all 254 tonnes of 100% acid capacity can be attributed to the modernisation of existing plants and the installation of new plants in the non-ferrous sector of Japan's metallurgical industry. Use of spent oxide, which up to the first half of 1959 played a small part as a raw material source for sulphuric acid in Japan, has now been abandoned.

Consumption

The most notable feature of the acid consuming industries in Japan is the marked decline (−16%) in sulphuric acid consumption in the nitrogenous fertilizer sector after a long period of steady expansion. This is attributed to the rationalization now under way in Japan's

fertilizer industry and the decrease in production of ammonium sulphate, mainly in favour of urea.

The increased consumption in the oil and fat industry (+34%) is the result of the rapid improvement in living conditions in Japan and popularization of electric washing machines. Demand for powdered soap and surface-active agents has increased sharply. At present Japan's soap and fats industry is doing a brisk business and for some time detergents from coconut oil and whale oil by the high-pressure reduction and sulphonation method have been manufactured. Large quantities of detergent materials are also being exported. More recently, the industry has begun the manufacture of surface active agents by sulphonation of alkybenzene. Output of detergents in 1958 amounted to 30,000 tons; last year it was even greater and production in the next few years is expected to increase steeply.

Fibre Industry Booming

The man-made and synthetic fibres industry, after the recessionary trends in 1957 through to 1958, is now booming and hence acid consumption has once more risen (+17%) with demand. The Japanese steel industry is in a very satisfactory position and acid consumption has shown a marked increase (+19%). The fall in acid usage by the tar products industry is accounted for by the newer refining techniques now being employed.

Trends

The trend evident over the last three years regarding sulphuric acid produced from smelter gas is now much more delineated. Some 12% of acid is now produced from copper concentrates and 8% from zinc blende. In recent months Japanese efforts to secure new sources of copper concentrates have been intensified, particularly in Australia, the Philippines and also in South America. For example, the whole of the Peko mine's output, which was to have been smelted at Port Kembla, has been bought by Japan. Because of discriminatory import controls imposed on blister and refined copper by the Japanese Government which result in a high metal price in that country, Japanese smelters are able to outbid the Australian smelter for copper concentrates, and in fact some Australian sinter plants are now idle for want of raw material. So strong is the feeling in Australia at the present time that the Australian Government may be asked to take action.

Despite the rising production of hydrogen sulphide and recovered sulphur from the refineries now coming into operation, Japan's acid output—the third largest in the world—can be expected to continue to be based on the present raw material supply pattern. Only a severe deterioration in the indigenous pyrites and sulphur ore mining industry could open Japan as a market for brimstone for sulphuric acid manufacture.

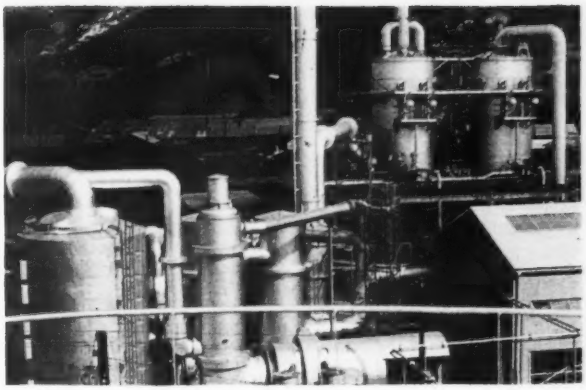
Concentration of Sulphuric Acid for Decomposing Kara-Tau Phosphorite

SULPHURIC ACID in concentrations varying between 40.3% and 68.7% H_2SO_4 has been used to decompose Kara-Tau phosphorite by M.E. Pozin *et. al. (Zh. prikl. Khim* 1960 *33*, (9) 1969). The amount used was 100, 105 and 110% of the stoichiometric amount. The rate of decomposition, it is reported, varies with the supersaturation of the system, with the crystallizing solid phase, and also with the resistance to diffusion caused by decomposition on the surface of phosphorite particles. Adding a smaller amount of more concentrated acid results in greater supersaturation by calcium sulphate and in increased diffusion resistance.

Curing the product for 14 days increased decomposition to monocalcium phosphate from 81 to 85.3% up to 92.8% to 96% (using 40% acid) and from 72% to 77% up to 73 to 80% (using 62.2% acid). Decomposition by 40% acid is not followed by crystallization of monocalcium phosphate even when the level of decomposition is 96% to 97%. Use of dilute acid (50 to 55% H_2SO_4) in superphosphate production gives better exploitation of raw material but it is inexpedient since the product is high in moisture content and low in P_2O_5.

New Monsanto Acid Plant for Mitsui Mining

Capacity increased by 110 tonnes a day



General view of Mitsui Mining's new sulphuric acid plant

ON stream at the start of the year was a new Monsanto contact acid plant at the Hibi Smelter of Mitsui Mining and Smelting Company Limited, Tokyo, Japan, of 110 tonnes a day capacity. The plant brings Mitsui Mining's monthly sulphuric acid production to 5,800 tons.

Raw Materials

Part of the raw materials used in production of acid is gas from the copper ore roasting furnace while the major part of the raw materials is an exhaust gas from the company's copper smelter. The new plant has been designed to collect and utilize the exhaust gas from this smelter.

Supply of raw materials for this plant and a previously erected 100 tonnes-a-day plant are as follows:—

Plant Capacity	Roaster Gas m³/min.	Smelter Gas m³/min.	Total
100 tonne/day ...	100-120	0-150	100-270
110 tonne/day ...	100-120	0-225	120-325
Total	**220**	**0-375**	**220-595**

Density of the roaster gas, Mitsui Mining state, is 7.0%, while that of the smelter gas fluctuates between 3.0% and 8.0%

Production

Production rate of sulphuric acid at the Hibi smelter acid plant fluctuates since the supply of raw material, namely the smelter gas, varies from time to time. In fact the supply of the raw material is often affected by the operational conditions in the copper smelting section from which the gas is emitted intermittently. Monthly production is reported as about 5,800 tonnes.

Facilities and Operation

To overcome the difficulties associated with the uneven supply of raw material, as much as possible of the various plant sections have been controlled automatically. This also serves to save labour and electric power produced by the plant.

Gas Supply Control

To cope with stoppage or variation of smelter gas, the amount of gas led to the converter group is automatically controlled by the adjustment of the rotation of the blower as well as operation of valves.

Temperature and Density Control

To overcome temperature changes and differences in density of the gas feed there are automatic controls for temperature, density of the acid in every tower and for the acid in circulation.

Mitsui Mining's Acid Production

The older Hibi sulphuric acid plant produces 98 tonnes a day and Mitsui Mining's total acid capacity is 578 tonnes a day. The new installation increases the company's acid production capacity by 36% to 788 tonnes a day.

This development is part of the large expansion programme of Japan's copper industry which also manifests itself in the widespread contractual arrangements with producers of copper concentrates in the Philippines, Australia, Chile and Canada. The trend towards the greater use of smelter gas obtained from copper concentrates has been evident since 1959. Last year 499,000 tonnes of copper concentrates were consumed, compared with 387,000 tonnes in 1958—29% increase.

Firmer Tone to World Sulphur Markets

SULPHUR markets throughout the world displayed a firm tone at the start of 1961. In Western Europe and in most major importing countries overseas indications of firmer prices for 1961 had reached consumers in October and November and, recognising the need for greater price stability for this basic commodity, sulphur consumers have virtually without exception accepted, if not welcomed, the new trend. In the U.S.A., which is not only the largest single market but also the largest importer of sulphur in the world to-day, Pan American Sulphur Company announced higher prices for new customers on the 19 December. By establishing the new f.o.b. prices $2 per ton above the old price level, the company, with exports from Mexico to the U.S.A. exceeding one-half million tons sulphur annually, has given effect at home to the trend apparent outside the Western hemisphere.

The U.S. domestic producers have welcomed this positive development as it enables them to reduce the freight contributions and other allowances which had hitherto represented the gap between effective and posted f.o.b. prices. The initial impact is not likely to be great, and it will take some time before old contract commitments expire and become subject to re-negotiation on the basis of new terms. Nevertheless, the prospect of improving net revenue at a time when the need for a conservative production policy by the Frasch sulphur producers limits the rate of quantitative expansion, will be a source of satisfaction to managements and shareholders.

Improved Customer Service

It is also of interest that now that the futility of price cutting as an effective weapon of competition in the sulphur industry has been recognised, producers' efforts to improve their customer service is making rapid strides. Activities of the principal Frasch sulphur producers centre on deliveries in liquid form and Texas Gulf, Pan American and Freeport Sulphur companies are bringing in ocean-going sulphur tankers--converted from carrying oil --which will serve distribution points and customers' works along the Atlantic East coast. Along the Mississippi Texas Gulf and Freeport are expanding their facilities or establishing new ones for the carriage, storage and distribution of liquid sulphur and to support these operations all the companies are improving and extending their mine and shipping installations for the anticipated volume of demand which within two years may result in 70% of U.S. deliveries being made in liquid form.

An interesting and valuable contribution is being made in the field of sulphuric acid technology by Pan American Sulphur Company which, in a small contact acid plant serving the company's filtering installation at Jaltipan, will conduct a series of fundamental research projects for the benefit of the industry as a whole. (See Page 36.)

Liquid Sulphur Deliveries

In a more modest way, efforts on these lines are being made in Western Europe : here the ability of SNPA to deliver in relatively small parcels is attractive to consumers, also favoured is delivery—in conformity with day-to-day needs—of liquid recovered sulphur from oil refineries, of which the activity in the U.K. by F. W. Berk and Company, who supply by road tankers, is an outstanding example. U.S. and Mexican Frasch sulphur producers have established stocking points but so far only for solid sulphur.

Europe's pyrites industry, largely through the enterprise of DKH, is also aiming to improve its services to customers, and in the spring of this year the merits of new technological developments in roasting practice, with particular reference to pyrites residues, will be reviewed and a symposium of papers presented.

Preliminary data of world sulphur production in 1960 indicate an overall increase in production of approximately 6%, fractionally

World Production of Sulphur

	'000 tonnes		Change	
	1959	1960	'000 tonnes	%
Brimstone	8,291	8,981	690	+ 8.3
Frasch	5,936	6,057	121	+ 2.0
Recovered	1,886	2,477	591	+31.3
Native	469	477	− 22	− 4.7
Pyrites	5,969	6,240	271	+ 4.5
Others	2,740	2,792	52	+ 1.9
FREE WORLD	**17,000**	**18,013**	**1,013**	**+ 6.0%**
U.S.S.R., China and Eastern Europe				
Brimstone	589	638	49	+ 8.3
Pyrites	2,329	2,429	100	+ 4.3
Others	485	602	117	+24.1
	3,403	**3,669**	**266**	**+ 7.8**
WORLD	**20,403**	**21,682**	**1,279**	**+ 6.3**

Free World — Production of Sulphur

'000 tonnes — sulphur content

	1959				1960			
	P	S	O	T	P	S	O	T
Western Europe	3,315	949	1,535	5,799	3,444	1,306	1,576	6,326
Australia & Far East ...	1,576	240	378	2,194	1,686	259	400	2,345
Africa & Middle East ...	242	26	46	314	245	33	46	324
South America	1	50	20	71	—	54	20	74
North & Central America	835	7,026	761	8,622	865	7,329	750	8,944
Total	**5,969**	**8,291**	**2,740**	**17,000**	**6,240**	**8,981**	**2,792**	**18,013**

more in consumption, the difference being represented by a decline in stocks of brimstone. Those of U.S., Mexican and Italian producers are estimated to have decreased one-half million tons whereas in Canada and in France stocks rose by about 160,000, and 100,000 tons respectively.

In 1961 available capacity of Frasch sulphur is substantially higher than in the preceding year, as the loss of production from Jefferson Lake's Starks and Clemens domes will be outweighed by Freeport's Grand Isle and Lake Pelto domes operating during the full 12 months' period. The main addition to plant capacity and production is, however, in recovered sulphur and France and Canada can be expected to add about 400,000 tons to output, employing plant capacity which will have risen to over 2 million tons.

The 4½% expansion in world pyrites production is attributable to greater domestic consumption in the pyrites producing countries, notably Japan and to a lesser degree Italy, and to greater demand in Western Europe.

Production and consumption of sulphur in other forms has continued to rise — 1.4% in 1960—and 2,792,000 tonnes sulphur equivalent reflects increased use of SO_2 in smelter gases and of anhydrite in ammonium sulphate production. Maintenance of the prevailing trend of rising world sulphur use should boost consumption of sulphur in all forms in 1961, but despite this the gap of supply and demand will widen.

World Usage Rising

The activities of the Sulphur Institute, whose main task is the promotion of new uses of sulphur, are quickening. Following the establishment of the London office under vice-president Rene Leclercq, formerly director of research of Union Chimique Belge, valuable co-ordination of a number of separate research efforts is being achieved and in the longer term the renewed emphasis on the versatility of the element sulphur and its main derivatives as raw materials for chemical and possibly other industries cannot fail to bear fruit.

PRICES

Brimstone

U.S.A. At $25 per ton f.a.s. Gulf Ports for bright sulphur and discounts of $1 per ton for off-colour material and $1.50 for delivery f.o.f. ex mine, posted U.S.A. prices remain unchanged. Posted prices still only apply in a

small number of protected markets and the bulk of domestic and export sales is based on " delivered " prices embodying freight contributions or other discounts of up to $3.50 per ton. The bulk of U.S. Frasch sulphur is priced at $21 to $22 per ton for bright and $20 to $21 for off-colour, but export sales, and new sales, although not as yet volume tonnage to established customers in the East, is priced to give an f.o.b. equivalent of $23 to $24 for bright sulphur and $22 to $23 for off-colour grade.

In the Florida (Tampa) region delivered prices are $25 per ton, rising to $27 per ton. In the North Central State of the Great Lakes' area prices appear to be unchanged at $26 to $27, while along the Atlantic east coast ports they are reported to be in the range of $26.50. The monthly volume of liquid sulphur deliveries is not attracting any premium and any savings represent a direct benefit to users.

Mexico. Posted prices by Pan American Sulphur Company as from 19 December, 1960, are $23.50 for bright and $22.50 for off-colour sulphur f.o.b. Coatzacoalcos and for deliveries out of Tampa the company has also raised price schedules by $2. These prices apply to new business and progressively to established customers as their contracts become renewable. Gulf Sulphur Company has similarly adjusted quotations. In deliveries to the U.S.A. Mexican shippers continue to benefit from the favourable differential between rates out of Coatzacoalcos and the tariff for U.S. flag vessels carrying sulphur from U.S. Gulf ports.

Export Prices

In European markets delivered prices of U.S. and Mexican Frasch sulphur and French recovered sulphur range from $26.50 to $31. The prices for 1961, generally up to $1.50 higher than prevailing last year, have found acceptance even in the more competitive markets. Frasch sulphur producers are favoured by the continued availability of vessels at cheap freights ($4.10 f.i.o.). Delivered prices in India tend to be higher as the result of rising freight charges; current offers for delivery in Bombay are $30 to $31 and in Calcutta $31 to $32. Russian sulphur continues to be offered at up to $2 below corresponding delivered prices of U.S. and Mexican Frasch sulphur and French recovered sulphur.

Recovered Sulphur

Generally in Western Europe prices of indigenous recovered sulphur are slightly firmer.

In Western Germany prices in the Ruhr and at Hamburg of domestic brimstone recovered at oil refineries and by Ruhrgas range from DM 118 to 125 plus turnover tax, handling and service charges.

Recovered sulphur in Belgium is sold at B. Francs 125 to 135 per tonne, and in Holland D.Fl. 99 to 100. In France delivered prices to domestic consumers range from Frs. 13,000 to 14,000 per tonne.

In Sweden domestic supplies by Svenska Skiflerblje AB. are sold at S.K. 158, and imports of Orkla sulphur are priced similarly.

Recovered sulphur prices in Western Canada remain based on $23.50 per ton ex plant. Delivered prices, incorporating freight charges, are subject to wide fluctuations in view of the large area of the market, which extends throughout Alberta, British Columbia, and the U.S. North-West Pacific states. As yet no reductions of the rail tariff have been secured by suppliers and the high cost of rail freight from recovery plants to the principal consumer market in the Great Lakes area still gives Frasch sulphur a freight advantage of up to $10 per ton. Exports from Vancouver are expected to be based on prices corresponding to those of Frasch sulphur from the Gulf.

Pyrites

During the first half of 1961 prices of European pyrites remain identical with those ruling in 1960. Rio Tinto and Tharsis crude fines pyrites are sold at 60s. per tonne for 48% sulphur f.o.b. Huelva; other Spanish pyrites are priced correspondingly within narrow limits and Rio Tinto " confines " gravity concentrates are quoted 10s. per tonne lower. Portuguese pyrites are also based on 60s. per tonne f.o.b. Setubal and Cypriot and Norwegian pyrites are priced competitively. The average export value for Cypriot iron pyrites during the period January to September 1960 was £2 14s. 6d. per ton.

As the result of renewed falls in price of copper and the slight (1.3%) decrease in purple ore prices to DM 0.72 per unit of iron residues

values have deteriorated slightly. Cupreous cinders are unlikely to exceed 75s. per tonne and non-cupreous cinders 70s. per tonne free Ruhr.

SUPPLY

In the U.S.A., production of Frasch sulphur remains restricted to about 400,000 tons a month. Operations at Jefferson Lake Sulphur Company's two lesser domes—Starks and Clemens—are virtually at a close, having contributed in the past two years about 15,000 tons a month to U.S. suppliers. Clemens dome was brought on stream in 1937, since when it has produced just over 3 million tons sulphur; Starks dome, on stream in 1951, produced about 850,000 tons.

Mexico

Frasch sulphur production is being maintained at a monthly rate of about 100,000 tonnes. Pan American Sulphur Company's operations continue at about 80,000 tonnes a month; output flagged of Gulf Sulphur Corporation which, in the latter part of 1960, is expected to raise its level of production towards 25,000 tonnes a month now that technical management of the Las Salinas dome has been placed under the direction of Mr. M. J. Dupuy.

Poland

The Tarnobrzeg plant was officially commissioned on 4 December 1960. According to revised estimates it is now planned to raise production of elemental sulphur from ores to 114,200 tonnes of 99% purity. With the exception of export deliveries of about 30,000 tonnes sulphur to Czechoslovakia, the bulk of the output is to be consumed in Poland, where sulphuric acid output is to be increased from just over 500,000 tonnes in 1960 to 804,000 tonnes in 1961.

Turkey

Production of elemental sulphur increased from 1,500 tonnes in January 1960 to 1,850 tonnes in July 1960, making the output for the first seven months nearly 10,000 tonnes.

Indonesia

A Bill embodying new laws for the mining and petroleum industries has been presented by President Sukarno and is now awaiting ratification by Parliament. All natural resources are divided into three categories, "strategic," "vital," and "others." Sulphur is classified as "strategic" mineral and may in future only be exploited by the Central Government or by the latter in partnership with a provincial Government. It is hoped that the new laws will promote development.

U.S.A.

Output of recovered sulphur averages 60,000 tons monthly. New recovery plant which came on stream in 1960 is increasingly contributing to the volume of supplies.

Lacq

Production of recovered sulphur during the 11 months' period to end November totalled 700,420 tonnes following the peak output in November of 82,980 tonnes. Shipments in 1960 totalled 685,781 tonnes, of which 409,381 tonnes was exported. As the result of the year's operations it is estimated that stocks increased by 100,000 tonnes.

East Germany

Output of elemental sulphur recovered from H_2S extracted from brown coal gas at the Leuna works, which totalled 107,856 tonnes in 1959, is expected to have receded slightly in 1960. A further reduction in 1961 is probable as an increasing volume of fuel oil is used in gasification.

Canada

Output in 1960 of recovered brimstone from natural gas in Canada is estimated at 446,000 short tons and 42,000 short tons recovered from oil refinery gases and nickel sulphide matter. This year, total brimstone production is expected to rise to about 600,000 short tons. In a recent survey by the Department of Mines and Technical Surveys, Ottawa, recovered sulphur output in 1962 is forecast at 3.15 million short tons rising to 4.1 million short tons in 1966.

The factor determining the level of sulphur production is the quality of raw gas processed to meet the rising gas demand in Canada and for export to the U.S.A. In the immediate future production will be based largely on present known reserves which as the result of the historical pattern of exploration and

Pyrites...

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...Europe's principal source of sulphur

development in Alberta are predominantly sweet and low sulphurous. Due to the increasing rate of discoveries of Mississippian and Devonian gas reserves in recent years in the Foothills area of Western Alberta, the majority of which are sour, the average H_2S content of disposable gas reserves for the next 10 years of 36 trillion cu. ft. is 12%, compared with 3% of sour gas in 1960 production. It is anticipated that this proportion will increase to 6% by 1969, or possibly higher if the main weight of gas exploitation under the stimulus of gas exports to the U.S. North-East and Pacific States shifts to the Western Foothills.

A decision regarding the development of the Athabasca tar sands, one of the world's largest potential sources of oil and sulphur, on an application by Great Canadian Oil Sands Limited, has been deferred by the Alberta Oil and Gas Conservation Board and the company was invited to a new hearing during the first half of 1962.

Argentina

A sulphur recovery plant to process an H_2S stream at a YPF oil refinery is to be built by Parsons/Power Gas Limited of London. The plant, operating at a recovery efficiency of not less than 95%, will have a daily capacity of 42 tons and yield sulphur of minimum purity of 99.5%.

Finland

Construction of the ore treatment plant, smelter and sulphur recovery facilities of Outukumpu Oy is progressing and it is anticipated that the plant will come on stream in 1962. Output is projected at about 80,000 tonnes a year.

PYRITES

The level of production and shipments by European producers of pyrites which in 1960 is estimated to have been 4% higher than 1959, is being maintained. The Tharsis Sulphur and Copper Company, the second largest pyrites producer in Spain, is producing slightly in excess of 700,000 tonnes a year to fulfil domestic commitments of about 300,000 tonnes and export orders of over 400,000 tonnes. Increased production of pyrites is expected in the Murcia district of Spain following reports that substantially higher deliveries are to be made to Egypt. Recent enquiries for shipping space were of the order of 100,000 tonnes pyrites combined with 100,000 tonnes superphosphates from Carthagena to Alexandria.

Exports of iron pyrites from Cyprus during the first 10 months of 1960 totalled 681,751 tons, 3½% more than in the same period of 1959; cupreous pyrites shipments were, however, 29.5% lower at 216,616 tons.

Production in Italy, notably at the mines of Soc. Montecatini, is reported to have increased slightly. A new pyrites deposit has been discovered by the company at Calceranica, near Lake Caldonazzo in the Trentino, where for years past the company has been mining cupreous pyrites.

In Australia the Government has adopted the Tariff Board's recommendation and has decided to implement the lower rates of Bounty of the two alternatives recommended. It is thought that this decision will not affect the current level of production and use of about 270,000 tons a year of pyrites and concentrates, but will discourage new projects, both as regards pyrites production and sulphuric acid manufacture based on pyrites. Formerly a prominent supplier of pyrites to roasters in New South Wales, Lake George Mining Corporation is now expected to be exhausted in two and a half to three years' time as the recently concluded exploration work failed to produce positive results.

SULPHURIC ACID

New Projects

Aruba. A U.S., Dutch, West German and Italian consortium has formed Aruba Chemical Industries which will build a number of plants to manufacture nitrogen and phosphate fertilizers. The project, due to be started in summer 1961, will include sulphuric acid production facilities. DFP. 50 million will be invested.

Australia. Titanium oxide production facilities are to be built by Laporte Industries Limited at Bunbury, West Australia. Designed capacity is 10,000 tons a year TiO_2 pigment, and the plant is to have sulphuric acid facilities to meet the requirements estimated at 35,000 to 40,000 tons a year (100% H_2SO_4).

Bulgaria. In 1961 new plant capacity is to be brought on stream to raise output to

211,000 tonnes (100% H_2SO_4), nearly double that of last year.

France. Production of sulphuric acid, which in 1960 totalled about 2.06 million tonnes (100% H_2SO_4) is to rise to 2.9 million tonnes by 1965. Sulphuric acid capacity based on the use of brimstone is to be increased by 135%, and it is anticipated that five to six major new plants will be built. Wastage of pyrites plant is expected to reduce available capacity about 27%, and this is not to be replaced. A substantial addition to French sulphuric acid supplies will result from a 50% increase in by-product sulphuric acid manufacture at zinc smelters.

India. By-product sulphuric acid facilities of 25,000 tonnes a year (100% H_2SO_4) are to be built in conjunction with the zinc smelter project at Udaipore in Rajahstan. The project of Soc. Minière at Métallurgique de Peñaroya, which is being executed by Krebs & Cie., of Paris, will include a 75,000 tonnes a year superphosphate plant.

U.S.S.R. As part of the major drive to expand fertilizer production facilities it has recently been announced that the largest works yet built in the U.S.S.R. is under construction in Lithuania. At Krasoyarsk a major sulphuric acid/fertilizer plant which will process phosphorite from the Sayan range on the Upper Yenezei river is due to come on stream in spring 1962. By-product sulphuric acid is to be produced at the Balkash copper works in Kazakstan, where it is claimed that the world's first industrial cyclone furnace to roast copper ores is due to come on stream this year.

Review of 1960 Freight Charterings and Rates

THE YEAR 1960 started well for consumers of pyrites when the Spanish mines abolished the 6% commission hitherto payable to suppliers under all charter parties made for Huelva loadings. Worth some 1s. 6d. to 2s. 0d. a ton indirect price concession to buyers who no longer had to pay freights adequate to cover brokerage to sellers, it also removed what had previously been a considerable impediment to freight market operations. Many shipowners had resented having to pay away up to 10% of their gross freight, which was often the case after commissions to their own and receiver's brokers had been added.

Pyrites Bookings

Pyrites bookings for the year, although not spectacular, were solid and reported fixtures in at least three months reached the 100,000 tons mark. Freights from the Mediterranean to North-West Europe displayed remarkable stability, as indicated by traffic from Morphou Bay or Vassiliko to Holland. In January, when the winter "boomlet" was at its peak, the top rate for Cyprus pyrites was only 29s. 6d. a ton, a bare 5s. up on the lowest figure during the shipping slump which started in mid-1957. By the middle of the year Cyprus/Rotterdam was again down to 25s. 0d., and only rose by 1s. 0d. or so by the close of the year, at a time when some other freights were as much as 60% above summer levels. A similar picture is seen in the case of shipments from Huelva to main Continental ports as well as from Setubal to Belgium; with a freight average for the year at around 24s. 0d.

Slump in Freights Ending

Over a considerable period rates of freight on pyrites from these three main areas have fluctuated much less than world freights in general and it would seem likely even though there are signs that the general slump is ending, that this advantage will persist. The Communist countries in the Balkan area are becoming increasingly heavy purchasers of ores from India and the Far East, a trade also strong to Italian ports. Once discharged these vessels usually have to get back to Europe and the Cyprus producers, aided by an aggressive chartering policy, can frequently secure them at very low freights. Spain and Portugal are served to a considerable extent by aged vessels not suitable for long voyages, especially during

the winter months. These countries also have commitments under trade treaties to take materials from Continental ports in ships of their own flag. Here again, being tied to a given route the shipowners cannot exploit the open freight market. This applies even to quite small vessels and is evidenced by recent payments for pyrites cargoes of 49s. 0d. a ton Huelva to Drogheda, 38s. 3d. to Hull and 36s. 6d. to Ipswich, at a time when Portuguese ships of similar size could get no better than 24s. a ton from Huelva or Setubal to Belgium.

Brimstone Shipment

Shipments of brimstone from Bayonne, although on a considerable scale, were mainly in small lots, to meet consumer demand. Most ships fixed for Lacq sulphur to British ports were hardly out of the coaster class. Freights in consequence were high in relation to the length of voyage, ranging from around 29s. to 38s. a ton; that is within $2 a ton of those current for large full cargoes ex the Mexican Gulf. Bookings from U.S. Gulf/Coatzacoalcos to the United Kingdom were again on a heavy scale, but freights varied little, falling from January's 52s. 6d. to 45s. 0d. at midsummer and advancing at the year's end to 50s. 0d. a ton. For the Near Continental ports charterers were able to secure lower freights owing to their ability to handle much larger ships. The lowest was in March, when a 17,000 tons bulk-carrier accepted only $4.50 a ton (less 90 cents for stevedoring) from the Gulf to Rotterdam. But even at the close of 1960 fixtures were being made at only 50c. more.

Carrying Bulk Sulphur

As long as there is a plentiful supply of bulk-carriers not suitable for grain transport, the transatlantic shippers of sulphur may well be able to hold off the impact of general freight rises, but it remains to be seen whether the recent loss of an Indian ship laden with sulphur, following a fire in her cargo, will to any extent revive old prejudices. When shipments of elemental sulphur to the U.K. and Europe were first made after the end of World War II shipowners marked the risk of fire and of damage to ships' plates by "free acid." As a result, and during that period, sulphur paid the equivalent of $1 to $2 above the going rate for phosphate from nearby Florida ports. During the last decade sulphur has rightly become a generally acceptable cargo and has not been subject to penalties compared with other bulk minerals.

The following freight statistics are based on known charterings, save where recent reports are lacking. In such cases "notional" figures calculated on freights paid for other commodities moving in the same direction are inserted.

EXPORTING AREA	DESTINATION	FREIGHTS PER LONG TON Month of January 1961	1960	1959
U.S. Gulf or Mexico	United Kingdom[1]	48s. 9d.	52s. 6d.	48s. 0d.
,,	N.W. Europe[2]	$5.00	$6.00	$4.50
,,	India[3]	$10.00	$9.75	$9.00
,,	Australasia[3]	$11.75	$12.70	$11.00
,,	Brazil[4]	$5.35	$5.50	$6.75
Bayonne	N.W. Europe[4]	18s. 6d.	22s. 6d.	14s. 0d.
,,	United Kingdom[1]	32s. 6d.	36s. 0d.	23s. 9d.
Huelva	Antwerp[5]	27s. 0d.	26s. 0d.	22s. 9d.
Cyprus	Rotterdam[4]	26s. 6d.	29s. 6d.	25s. 6d.
,,	United Kingdom[6]	37s. 6d.	45s. 0d.	38s. 0d.

KEY TO CHARTERING CONDITIONS :—

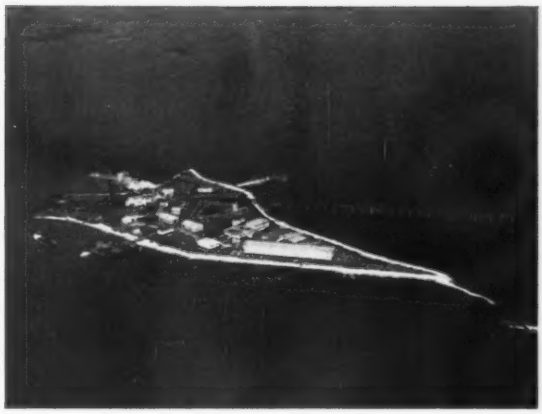
1 Cargo f.o.b., shipowner to pay current rate per ton for discharging.
2 Ship to pay 50 cents ton for loading and 40 cents per ton discharging.
3 Ship pays 50 cents per ton loading and current rate discharge.
4 Ship pays 2s. 6d. ton loading and 2s. 6d. ton discharging.
5 Cargo f.i.o. (no charge for loading or discharging).
6 Ship pays 2s. 6d. ton loading and current rate discharge.

Page 22, second column, lines two and three:—

For 100,000 tonnes pyrites read 50,000 tonnes
For 100,000 tonnes superphosphates read 125,000 tonnes

Freeport Sulphur Company's Activities

- **Liquid Sulphur Programme**
- **Lake Pelto Project Launched**



This view of Lake Pelto shows part of the mile-long lateral leading from the island base to the field area. Facilities shown, starting from left to right, are the mining barge, shops building, warehouse, recreation, dining building and dormitory. Two wharfs service the island

LIQUID SULPHUR was first supplied in the U.S.A. in the 1940's and modest deliveries were moved by rail tankers. Now the demand for sulphur in liquid form is such that it is estimated that within three to four years up to 70% of all U.S. domestic shipments will be in this form as liquid sulphur is freely available.*

$23 million programme

For some years Freeport Sulphur Company has been supplying liquid sulphur for barge shipments direct to customers' plants located in Alabama, Arkansas, Mississippi and Missouri on inland waterways.

In December last, Freeport launched a $23 million programme to move sulphur in liquid form into major market areas for storage and trans-shipment to its customers. The plans call for facilities capable of handling some 1.5 million long tons of sulphur a year in liquid form, or nearly two-thirds of the company's current annual sales. Included in the programme are new liquid storage terminals on U.S. inland waterways, to be served by special barges up the Mississippi, Illinois and Ohio rivers, and other terminals in Florida and on the Atlantic coast to be served by ocean-going tankers. Shipments up-river have already begun and the coastal shipments are due to start early this year.

The new terminal facilities and new marine equipment—estimated to cost about $20 million—are being financed and owned by independent marine transportation companies and operated under long-term contracts with Freeport. Additional facilities, costing between $3 million and $4 million are being provided by Freeport. Excluded from these costs are consumers' expenditures for their tanks and facilities.

Advantages of Liquid Sulphur

The rapid change from solid to liquid deliveries is occasioned by the strong and growing preference among consumers for this form of sulphur. The main reason for this trend is that most sulphur, whether for sulphuric acid or non-acid consumption, is used in liquid form and if delivered as solid sulphur, it must be remelted. Apart from the obvious convenience and lower plant handling costs with liquid deliveries, other advantages include elimination of losses in handling, which normally average 0.5%, avoidance of contamination from moisture, scale and other foreign solids, and dust which cause deterioration in plant and equipment.

The New Terminals

Up-river terminals for Freeport Sulphur are now under construction at Jolliet, Ill., near Chicago, and at Wellsville, Ohio, near Pittsburgh. Storage capacities will be large enough to ensure continuity of supply even if weather and water conditions of the waterways should slow down the rate deliveries. Loading facilities will be highly automated and will serve both road and rail tankers. Included in the development plans is provision for expansion at each

* In the U.K. current liquid sulphur deliveries from oil refineries are effected wholly by road through F. W. Berk & Co., and at about 50,000 tons a year represent 10% of the total U.K. brimstone consumption.

terminal and for addition of new terminals as market conditions warrant.

The terminals will supply the major sulphur - consuming areas, Jolliet serving primarily the states of Illinois, Indiana, Michigan and Wisconsin; and Wellsville will serve Ohio, Western New York area and Pennsylvania. Plants in Ontario, Canada, up to 800 miles away, will also be served by both terminals.

New Facilities for Port Sulphur

New storage and loading facilities are being added at the company's present installation at Port Sulphur to supply the expanded liquid sulphur service. Four new 9,000-ton tanks are being completed to bring total liquid storage capacity to almost 60,000 tons, and a new ship-loading tower is being added to the already extensive loading facilities at the dock.

Handling barge deliveries up-river and to Alabama will be Canal Barge Company Inc. and the trans-shipment terminals will be operated by Sulphur Terminals Company Inc., an affiliate of Canal Barge. The coastal shipments using S.S. *Louisiana Sulphur* will be operated by Global Bulk Transport Corporation and the Tampa terminal by Sulphur Terminals Company Inc. Plans for the Everett and Bucksport terminals have not yet been completed.

Developments at Lake Pelto

Newest Frasch sulphur mine of Freeport Sulphur Company is Lake Pelto, Louisiana, situated in the mainly coastal region, within three miles of the Gulf of Mexico. At the centre of the man-made island is a "floating" mining plant, and pipelines carry superheated water out to the wells.

Full-scale development at Lake Pelto began last June. Much of Bay Ste. Elaine's plant, equipment and materials, including the 200-foot long barge-mounted power plant is in use at the site. As at Grand Isle and the now closed Bay Ste. Elaine mine the sea water process is employed to tap the dome. Because of the proximity of the Gulf and incidence of storms, Freeport has designed Lake Pelto to weather the most powerful hurricanes. The buildings have therefore been anchored to piling supports, and the main field lateral lines, supported by 12-inch steel pipes, are at an elevation of plus 20 feet. The field area is about a mile from island base facilities. A relay station of structural steel fabricated onshore and towed to the site is set alongside the field lateral 4,800 feet from the island base. An additional 2,560 feet of steel-supported lateral leads from the relay station to the production area. The microwave radio-tower used at Bay Ste. Elaine has also been moved to Lake Pelto and has been extended by an additional 50 feet, so that it is now 150 feet in height.

The barge-mounted power plant used to mine Bay Ste. Elaine sulphur was floated into a narrow inlet dredged at one end of the Pelto island, and then sheet piling was driven across the inlet's mouth. Water was pumped in and the barge floated forward to a prepared foundation so that the barge is now well above the tide.

Production Reported Satisfactory

To date the few wells that have been steamed are reported to be producing satisfactorily but it is too early for the company to judge what the thermal efficiency will be or what level of production will eventually be reached. The plant has not been expanded since it was in operation at Bay Ste. Elaine when it produced 150,000 to 200,000 tons annually. Freeport, however, expects production at Lake Pelto to be of a higher order since the ore body appears to be more favourable.

Sulphur output from Lake Pelto will be transported to Port Sulphur in barges—a distance of about 75 miles. The sulphur from the first steamings is reported to be somewhat brighter than Freeport had expected, but the company feel that it is still too early to tell what the product will be eventually.

Liquid Sulphur Terminals for T.G.S. Cut Costs: Eases Handling

ALL sulphur Texas Gulf Sulphur produces in Texas is now being channelled through its new $3 million marine terminal at Beaumont, Texas. Both molten and bulk sulphur go through the new terminal and in so doing the company expect to cut handling and shipping costs by 35% to 40% and hence offset narrowing profit margins on sulphur prices. Another important advantage is the easy access to the Mississippi.

Also materially helping to cut costs is an ocean-going vessel to carry both molten and bulk sulphur from Beaumont to Tampa, Florida, and a molten storage terminal at Tampa completed in April 1959. The vessel, a converted Liberty ship contracted by T.G.S. from DeBardeleben Marine Corporation of New Orleans, can carry up to 7,500 tons of molten sulphur in steam-heated tanks. Or it can carry up to 8,000 tons of such dry cargo as ammonium sulphate, triple superphosphate, phosphate rock and potash from Florida to other Gulf Coast ports. A 5,000-ton deep-sea barge to move bulk sulphur to other ports along this coast is being used by T.G.S.

A DeBardeleban affiliate operates the Tampa terminal. This will hold 7,500 tons of molten sulphur in steam-heated tanks and 50,000 in bulk material.

Loading Time Lowered

At the Beaumont terminal new bulk-sulphur conveyors load either ships or barges at a 1,200 ton-per-hour rate—a 71% improvement over present loading rates in Galveston of 700 tons per hour.

Bulk sulphur vats at Beaumont are capable of holding over 1 million tons, a substantial improvement on facilities at Galveston, and four steam-heated tanks (three already in position) with a total capacity of 31,000 tons, will handle molten sulphur. T.G.S.'s nearby Spindletop plant will provide the steam.

Three barges can be loaded simultaneously with molten sulphur at a combined rate of 3,000 tons an hour and tank-ships will take on at the rate of 1,200 tons an hour.

No pumps are required; gravity flow is used. The terminal can load three molten sulphur barges, a molten sulphur tanker, and one dry-cargo vessel of 20,000 tons capacity at the same time. There is also room to tie another ship at the holding dock and to put 12 more barges in the barge basin. Beaumont is a highly favourable terminal for T.G.S. It is only a short distance from Spindletop, about 25 miles from Fannett and 40 miles from Moss Bluff, all principal molten sulphur sources for the company.

(Continued on Page 32)

New Texas Gulf Beaumont facilities for loading dry and molten sulphur. In the right foreground is a molten sulphur barge opposite three molten sulphur storage tanks: left centre is a tanker loading molten sulphur and right centre dry storage piles

Carbon Disulphide from Hydrocarbons

With particular reference to the Thacker Process

UNTIL recently the world output of carbon disulphide, except for 100 million lb. at Stauffer Chemical Company's La Moyne, Alabama plant, has been produced by the high temperature reaction of sulphur with charcoal in retorts of relatively small capacity. Economics of manufacture has prompted, however, new plant construction based on processes using hydrocarbons.

Within recent months there have been additions to petrochemical carbon disulphide capacity; thus, the 105 million lb. a year plant to be constructed by Carbosulf, a joint venture of Glanzstoff Courtaulds and Dr. Jacob Chemische Fabrik, at Cologne; the 20 million lb. a year plant now being built by S.N.I.A. Viscosa at Varedo, Italy; and in the U.S. Stauffer Chemical Company is building a second plant at Delaware City, Delaware, using the methane/liquid sulphur process which the company developed from the patent of Food and Machinery Company.

Main outlets for CS_2 are in the production of viscose rayon and cellophane—representing 75% world demand for CS_2—and the manufacture of carbon tetrachloride—15%-17% of CS_2 use. Other markets taking CS_2 in significant quantities are rubber accelerators and flotation chemicals and some other products such as thiocyanates, thiocarbanilide and certain agricultural chemicals. Severe competition from synthetic fibres has cut back activities of the viscose industry and in consequence CS_2 demand, whereas new routes to CCl_4 have limited the growth of CS_2 use in this field.

Thacker's process has these advantages:—

- **Higher yield of carbon disulphide**
- **Less by-products**
- **Less handling and heating of sulphur per ton of carbon disulphide produced**
- **Using heavy residium, it makes more than twice as many moles of carbon disulphide per 100 moles of reacted gases**
- **Recovery and refrigeration requirements much lower than for the methane process**

Carbon tetrachloride producers have been turning from the CS_2 route to direct chlorination of methane. Chlorination of CS_2 has the advantage of producing a minimum of by-products whereas the direct chlorination route yields carbon tetrachloride together with other chloromethanes and hydrogen chloride and its economics are therefore mainly influenced by the profitable disposal of the co-products; if by-product HCl is of no value, the CS_2 route is more competitive.

Carbon Tetrachloride Capacity in the U.S.A.
(Million pounds)

Producer and Location	Capacity (Est.)	Route
Allied Chemical Moundsville, W. Va.	5	Methane
Columbia Southern Chemical Barberton, Ohio	20	Perchloroethylene Co-Product
Diamond Alkali Painesville, Ohio	60	Carbon Disulphide
Dow Chemical Freeport, Tex. Plaquemine, La.	100	Methane Perchloroethylene Co-Product
Pittsburg, Calif.	30	Methane, Perchloroethylene Co-Product
Food Machinery & Chemical S. Charleston, W. Va.	50	Carbon Disulphide
Frontier Chemical Wichita, Kan.	15	Perchloroethylene, Co-product Methane
Stauffer Chemical Niagara Falls, N.Y.	100	Carbon Disulphide
Louisville, Ky.	20	Methane, Perchloroethylene Co-Product
Total	**400**	

In the U.S. at the present time, only two of the 10 carbon tetrachloride plants are based on chlorination of CS_2. As the carbon tetrachloride market is showing a growth rate of 5-6% a year due mainly to the increasing demand for derivative chlorofluoro-hydrocarbons as refrigerants and propellants which offsets the decline in carbon tetrachloride use as a solvent in industrial cleaning and in dry-cleaning; the economics of both routes are being subjected to close scrutiny.

Outlets for the lower chlorinated methanes are being developed, techniques to control the ratio of chloromethanes formed are closely controlled and the disposal of HCl are having a marked influence on the direct chlorination method.

The CS_2 industry, to make up for the setbacks it suffered in recent years, is currently expanding production capacity and concurrent with this expansion is engaged in active research into and further development of petro-chemical routes to carbon disulphide.

Direct Synthesis from Methane

In the direct synthesis of CS_2 from methane and sulphur—

$$CH_4 + 4S = CS_2 + 2H_2S$$

Co-product H_2S is reconverted to elemental sulphur in a separate unit and can thus be recycled to extinction. While non-catalytic operation is possible, commercially silica gel aluminia catalyst alone or combined with vanadium or chromium oxides or sulphides is employed.

Sulphur is vapourized and joined with the methane stream. The combined feed-stream is preheated and passed through the catalytic converter. The reactor effluent is cooled to effect condensation of unconverted sulphur. After the sulphur is separated, the gas is cooled further and " scrubbed " with gas oil in which CS_2 is absorbed. Recovery of CS_2 is effected by stripping, followed by distillation of the stripper overhead.

Refinement in the process that can be employed is the use of liquid sulphur as scrubbing medium in the sulphur-gas separator as in the Thacker process (see below). Other refinements are concerned with aspects of controlling the temperature of liquid sulphur and of the reactor feed gas. The critical feature of this process is the need to operate large units which limits its advantages to major bulk producers or, if installed for captive operations, to large viscose manufacturers.

The Thacker Process

Liquid petroleum fractions instead of methane gas are used in the process for production of carbon disulphide developed by Dr. Carlisle M. Thacker, technical director of Taylor Fibre Company, Norris Town, Philadelphia, who also developed and patented the methane route to CS_2 manufacture.

Recent evaluation studies indicate that the liquid petroleum process will cost about 25% less in plant investment and 15% less in production costs than the methane process. Not only are costs stated to be lower at high production levels, but it is reported that there are marked economic advantages at small capacity operations compared with the older multiple-retort process and also the methane process. The cost advantages stated to be inherent in Thacker's process would allow CS_2 users—principally manufacturers of carbon tetrachloride, rayon and cellulose film—to install small CS_2 plants for captive production. Moreover, it makes feasible the installation of production facilities in countries with widely varying degrees of industrialization. The greater flexibility in transporting liquid petroleum products can also have a marked effect on economics of plant location in CS_2 manufacture. Methane can be transported economically in large volume only through gas pipelines.

CS_2 from Hydrocarbons

Thacker's process is carried out as follows: Molten sulphur is introduced into the system indicated as (1) on the flowsheet. It flows through the sulphur condenser and then by line (2) to the sulphur vapourizer following which it flows through line (3) into the reactor system through (4).

Hot gases from the reactor system pass through line (5) to the sulphur condenser where they are cooled by countercurrent scrubbing with liquid sulphur. Unreacted sulphur is removed and with sulphur recovered from hydrogen sulphide together with fresh sulphur feed passes to the reactor system through lines (2) and (3).

Overheads from the sulphur condenser consisting primarily of hydrogen, hydrogen sulphide and CS_2, pass through line (6) to the absorber where CS_2 is absorbed in a suitable absorber oil, such as kerosene. The overhead from the absorber composed mainly of hydrogen and hydrogen sulphide passes through line (7) to the Claus kiln system where, by partial oxidation with air, hydrogen sulphide is converted to sulphur for recycle through line (8) to the sulphur condenser.

Carbon disulphide enriched oil passes through line (9) from the bottom of the absorber to the stripper where, by steam stripping, CS_2 is removed from the oil. The stripped oil passes from the bottom of the stripper through line (10) to the cooler and thence through line (11) to the top of the absorber.

Steam and CS_2 flow from the stripper through line (12) to the condenser and separator. After condensation and separation, impure CS_2 passes through line (13) to the distillation system where a pure, commercial grade of CS_2 is produced by distillation. The purified product passes to storage through line (4).

For these operations certain hydrocarbons that can be liquefied without appreciable decomposition are suitable charge stocks.

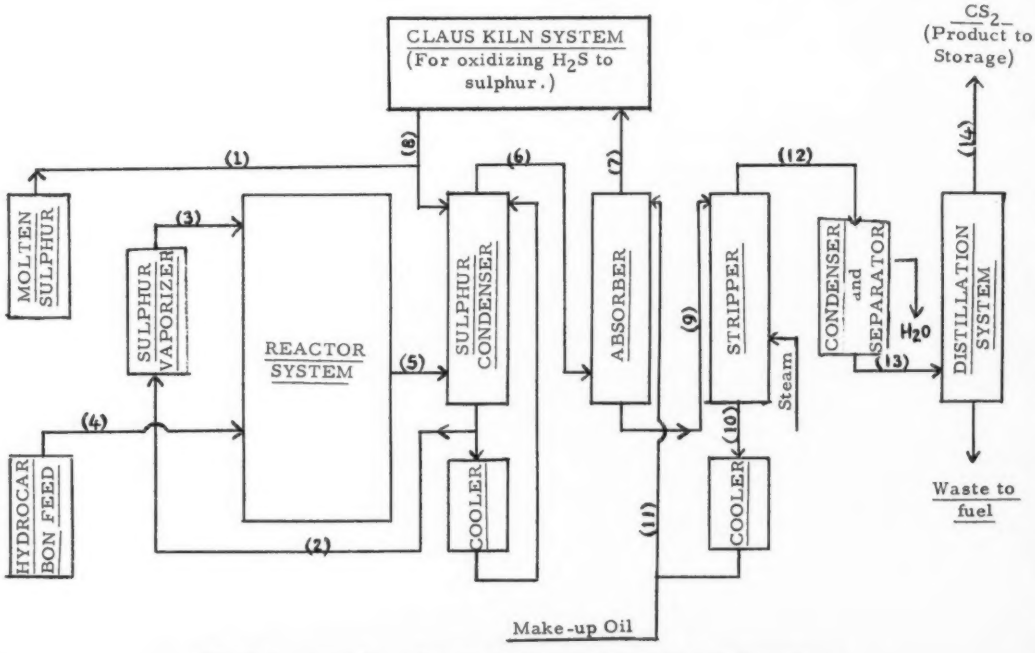
Patents Question

No indications are given in the flowsheet as to the nature of the reactor system as action with regard to patents has not yet progressed to a point where disclosure can be permitted. The process has been made available for pilot-plant development by interested companies and it is understood that a commercial production method will be announced in the near future for the following reasons:—

Methods for the recovery, separation and purification of CS_2 to commercial standards are identical to those used for the proved methane process and only design data for the reactor system remain to be completed. In this respect the reaction steps have already been demonstrated in pilot-plant.

Advantages

From recent evaluation studies, it is estimated that the liquid petroleum process will



Thacker's process for carbon disulphide manufacture from hydrocarbons

Comparison of methane vs. liquid petroleum fraction in CS_2 production

BASIS: One pass through converter

Methane Process $CH_4 + 4.4\ S = 0.75\ CS_2 + 0.25\ CH_4 + 1.5\ H_2S + 1.4\ S$

Fuel Oil Process

Fuel Oil $CH_{1.4} + 2.97\ S = CS_2 + 0.7\ H_2S + 0.27\ S$

Heavy Residue $CH + 2.75\ S = CS_2 + 0.5\ H_2S + 0.25\ S$

PROCESS FEED:	Approximate Values		
		Petroleum Liquid	
	Methane	Gas Oil	Heavy Residue
Empirical formula	CH_4	$CH_{1.4}$	CH
Feed needs purification before use	Yes	No	No
Economical transportation other than by pipeline	No	Yes	Yes
Assumed conversion per pass	75%	100%	100%
Sulphur (lb./ton CS_2 produced)			
To vaporize and superheat	4,940	2,501	2,316
To recycle:			
From sulphur feed	1,572	227	211
From H_2S oxidation	1,684	589	421
Total	**3,256**	**816**	**632**
RECOVERY & PURIFICATION (after sulphur removal from reacted gases):			
Moles gases to condenser per ton CS_2 produced	88	41	67
Moles CS_2 per 100 moles reacted gases	30	41	67

cost about 25% less in plant investment and 15% less in production costs than the methane process. Not only does the Thacker process cost less at high production levels, but there are decided economic advantages at lower levels over the methane and the old multiple-retort processes. Economy for both low and high level production makes feasible the installation of production facilities in countries with widely varying degrees of industrialization. The greater flexibility allowed in transporting liquid petroleum products can favourably alter the economics of plant location in CS_2 manufacture, for methane can only be transported economically in large volume through gas pipelines. Thus plants using methane gas must be sited either at the gas producing centre or along gas pipelines. Also, the raw materials used in the Thacker process—gas oils, fuel oils, and petroleum residues—are much cheaper than the natural gases from which methane is obtained. This is particularly true of petroleum liquids containing high concentrations of sulphur.

Other savings in the Thacker process result from the higher yield of CS_2 with less by-products and the reduced handling and heating of sulphur per ton of CS_2 produced. Using heavy petroleum fractions, more than twice as many moles of CS_2 per 100 moles of reacted gases are obtained and hence recovery equipment and refrigeration requirements are much less than those required in the methane process.

CS_2 Output

It is predicted that CS_2 plants using liquid petroleum fractions will more readily substitute the conventional retort plants and where needed to meet the demand for cellulose film, carbon tetrachloride, viscose rayon, etc., small captive units may be built.

Carbon Tetrachloride production

CS_2 is a raw material for one of the methods currently used to produce carbon tetrachloride. Although at present there is excess production capacity for carbon tetrachloride, demand for compounds based on the latter will be such that new plant capacity for CCl_4 production will be required. Thus demand for lower chlorinated methanes, such as methylene chloride and chloroform, is increasing and the most economical method of producing these products, including in many instances methyl chloride, is by direct chlorination of methane. Existing plants now producing CCl_4 by chlorination of methane can be expected to be converted to the manufacture of lower chlorinated methanes, thus requiring replacement of CCl_4 production capacity by new facilities.

CCl_4 is itself a basic raw material in the manufacture of chlorofluoromethanes, applications for which are growing steadily as refrigerants and as propellants in aerosol containers. About 65% of CCl_4 production is consumed in the manufacture of chlorofluoro-

hydrocarbons with the remainder used for solvents in industrial cleaning, grain fumigation, fire extinguishing and spotting and cleaning. The present 350 million lb. annual production of CCl_4 could therefore increase to reach 500 million lb. by 1970.

About 35 to 40% of CCl_4 now consumed, Dr. Thacker points out, is produced by the chlorination of methane and the balance by chlorination of CS_2. Chlorination of methane to form CCl_4 produces as by-product 0.95 lb. of hydrogen chloride (HCl) for each pound of CCl_4. Production of HCl from chlorination of methane and other inorganics, however, is creating a disposal problem, and even dumping is being resorted to if possible. This, of course, means a considerable loss of chlorine, and the added expense of neutralization. Because of the HCl disposal problem, it is believed that new CCl_4 production units would, for preference, use the CS_2 process rather than direct chlorination of methane.

Even if an economical process for extraction of HCl is successfully developed, it is expected that production of CCl_4 and CS_2 will still prove more economical than by chlorinating methane. In substantiation of this it must be pointed out that under present conditions, captive production of CS_2 and its subsequent chlorination to CCl_4 will still give a more attractive return than a methane chlorination unit, unless at least 75% of the chlorine value can be extracted consistently from the by-product HCl.

At present, world production of CS_2 is in excess of 1 million tons, of which about one-half arises in the U.S.A. Over the next 10 years U.S. demand is expected to increase by 200 million lb., requiring an average of 20 million lb. new capacity a year. Old obsolete charcoal retort plants are being replaced and annual capacity of these plants exceeds 300 million lb. In Europe and the rest of the world CS_2 manufacture is exclusively based on small retort plants and only last year saw the first methane/sulphur plant installation outside the U.S.A.—that of Swia Viscosa. These facilities will in time be converted to use fuel-oil, particularly where increased capacity is required.

The current development phase is centred on installations of larger capacity using methane, but it seems its application is limited to a small number and large CS_2 consumer markets. The greater flexibility as regards size of the Thacker process, which offers markedly favourable economics of manufacture, appears to give it greater scope in the great number of small markets which are rapidly expanding.

TEXAS GULF'S SULPHUR TERMINALS

(Continued from Page 27)

Texas Gulf is adding 9,000 tons capacity to its Cincinnati terminal and its Carteret, New Jersey, terminal of 26,000 tons will supply consumers in the New York area. Under construction at Norfolk, Virginia, is a 20,000 tons terminal.

PASCO's Liquid Sulphur Facilities

Tampa is the site chosen for Pan American Sulphur Company's first molten storage tank. It is expected that the 20,000 tons tank will be completed this month (February). The storage facilities will receive molten sulphur from Mexico in Pan American Sulphur's tanker, a converted T-2 tanker, of 14,000 to 16,000 tons, which is due to enter service in May.

Other Molten Sulphur Terminals

Last month, Tampa, Florida's first liquid sulphur terminal, went into operation. It has a storage capacity of 30,000 long tons of molten sulphur. Owner of the new facility is M.T.R. Corporation, which reports that it will cost approximately $1 million. Constructors were Wellman-Lord Engineering Inc. The project includes dockside facilities for unloading tankers, permanent storage tanks, and facilities for loading tank cars and railway wagons. The most modern methods of handling will be employed.

Setting up storage facilities for molten sulphur at Sayreville, New Jersey, to come by barge from Texas Gulf's Carteret terminal, is National Lead. American Cyanamid is also constructing storage tanks at Savannah to handle about 60,000 tons a year, while U.S.I. Chemical Corporation plans to complete its new storage facilities at Tuscola, Illinois, later this month.

In all, sulphur consumers are likely to own or operate over 75,000 tons of molten sulphur storage capacity.

Liquid SO_2 for Treating Chromate Wastes

Chrome reduction tanks, polishing tanks and final clarifier

CHROMIUM wastes at the Pontiac Motor Division of General Motors Division, Pontiac, Michigan, U.S.A., are recovered in the plating plant as far as possible by means of ion exchange, followed by vacuum evaporation. Using this method 550lb. of chromic acid are recovered daily. Sodium hydrosulphite is also used in the plating plant, by additions to the rack strip and clearing solutions in the continuous plating line, to reduce whatever chromic acid is trapped by the plating racks in the chrome plating tanks.

To deal mainly with the hexavalent chromium in the metallic acid system before the plating wastes are discharged to Pontiac's sewage treatment plant, use of gaseous sulphur dioxide on a continuous basis was considered the best available method for reducing hexavalent chromium. Use of copperas was considered as it is less expensive than sulphur dioxide. The problems presented by its use, however, made it undesirable, for 8lb. of $FeSO_4.H_2O$ are required to reduce 1lb. of chromic acid and the excessive sludge formed would add to the cost of sludge disposal. There are also associated feeding problems since copperas tends to cake.

Assistant Chief Chemist at Pontiac Motor Division, A.J. D'Orazio*, found that gaseous sulphur dioxide for processing chromium wastes on a continuous basis presented difficulties. Equipment which had been installed consisted of two-20,000 gallon Koroseal-lined tanks provided with agitators, two sulphur dioxide feeders linked to two 1-ton cylinders of SO_2. The gas was introduced into a water stream passing through the venturi in the feeder. Vaporization, however, occurred in the supply tanks and at a rate below requirements because of the tendency to freeze when the vaporization rate was too high. Loss of gas from the surface of the treatment tanks also occurred. Addition of more SO_2 supply cylinders did not make up the deficiency, so batch treatment using SO_2 in the liquid state was investigated.

Wash Treatment

The waste treatment plant for metallic acid wastes consists of two large holding tanks which are used for storage as well. The tanks, each having a capacity of 520,000 gallons, are of steel, lined with Koroseal, and provided with a Vorti Mix type agitator.

Treatment of waste is started after the holding tank becomes half full and a sample has been checked for hexavalent chrome concentration and pH. To lower the pH to 2.5 concentrated sulphuric acid is pumped in; the required amount of SO_2 is calculated from the hexavalent chrome concentration and then liquid SO_2 is added to reduce completely the hexavalent chrome. The SO_2 is added through a stainless steel diffuser placed directly beneath the agitator, after passing through a regulating valve, a rotameter and a check valve. SO_2 flows from the cylinder through $\frac{3}{4}$in. iron pipe, through a rotameter having a maximum flow rate of 250lb. an hour, then through a $\frac{3}{4}$in.

* Reported in paper presented to the 15th Annual Perdue Industrial Waste Conference, 1960.

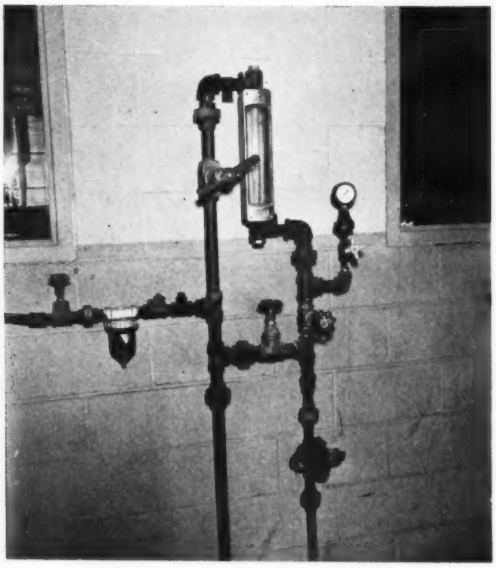
stainless steel pipe which enters the holding tank and is connected to the stainless steel diffuser. Provision has been made at the Pontiac treatment tanks to bypass the rotometer should it become necessary to add SO_2 at a rate greater than 250lb. per hour.

Experience at Pontiac Motor Division has shown that SO_2 requirements vary from three parts to nine parts per part of chromium. The excess is greatest when the hexavalent chrome concentration is below 5 p.p.m. The excess also varies with the copper concentration present in the wastes. The higher the copper content the higher the SO_2 requirement.

Chromium is reduced according to the following reactions:—

$$SO_2 + H_2O \longrightarrow H_2SO_3$$
$$2H_2CrO_4 + 3H_2SO_3 \longrightarrow Cr_2(SO_4)_3 + 5H_2O$$

From the holding tank the treated waste is pumped into the former chrome reduction tanks. The waste is then pumped from these

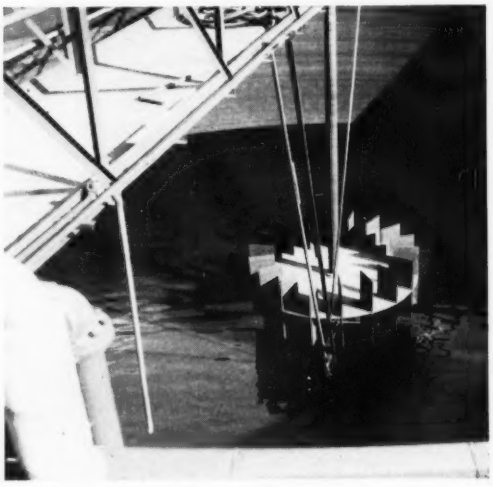


Rotameter and regulating valve

tanks into one of three polishing tanks where lime is added to raise the pH to approximately 7.0. From the polishing tanks the waste is pumped into one of the final clarifiers where lime is added to raise the pH to 9.5. Chromium is precipitated in the final clarifiers:—

$$3Ca(OH)_2 + Cr_2(SO_4)_3 \longrightarrow 2Cr(OH)_3 + 3CaSO_4$$

Installed capacity makes provision for the supply of up to three short tons of liquid SO_2



Stainless steel diffuser beneath agitator

per day and according to the composition of the chromate wastes, 0.8 to 2.5 short tons a day will actually be used.

Advantages

Main advantage of the batch treatment process using liquid sulphur dioxide over the continuous process using gaseous sulphur dioxide is the ability to reduce hexavalent chrome completely regardless of chrome concentration. In the continuous process the limiting factors are capacity of the feeders and the number of SO_2 cylinders connected to the feeders.

Reduction of SO_2 consumption is possible using liquid SO_2 and batch treatment for whereas with the continuous process over a 20-hour period a slight excess of SO_2 is required, using batch treatment an excess is only required on two occasions, i.e. for processing two tanks a day. Two reaction tanks, two SO_2 feeders and three pumps have been eliminated, too, using the batch process.

The Merox Process for Petroleum Refining Evaluation of Plant Performances

Just over one year since the introduction of the Merox process, some 30 units are now operating. One of its attractions is that existing treating equipment is quickly and easily converted.

A CATALYTIC process for removing sulphur compounds from a wide range of gasoline and light distillate oils has been developed by Universal Oil Products Co. of Des Plaines in Illinois and is now available for licence to refiners. The Merox Process may be used either for mercaptan extraction alone, in which it replaces conventional washing with sodium hydroxide solution, or for sweetening alone, in which it replaces the use of either copper chloride or sodium plumbite. Moreover it may be used to perform both functions in a combined operation. An undisclosed catalyst oxidises the mercaptans to disulphides at ambient temperatures and using atmospheric oxygen, the catalyst being used either dissolved in sodium hydroxide solution, or supported on a carrier in a fixed bed if greater reactivity is required.

Applications

In its application to the removal of mercaptans the Merox Process is similar to conventional extraction by sodium hydroxide solution except for the regeneration stage. With conventional extraction the caustic soda solution is regenerated by steam stripping at the solutions' boiling point. Steam consumption and the corrosive nature of the hot caustic solution makes this process expensive. With the Merox Process, regeneration is achieved merely by blowing a small quantity of air through the caustic solution after separating it from the hydrocarbons. Thus it is claimed that the Merox Process shows a considerable saving over conventional extraction. The disulphides formed are insoluble in the caustic solution and may be removed by a gravity separator.

The life of the catalyst is reported to have exceeded 20,000 barrels of oil per pound, and Universal Oil Products state that based on this figure the cost of the catalyst would be less than 1/10 of a cent per barrel of oil treated in a commercial unit.

Assessment of Process

Less than one year since its introduction this new low cost catalytic treating process has been widely installed and is continuing to gain approval from refiners. Installed and operating Merox units now total about 30, representing a design throughput capacity rapidly approaching the 100,000 barrels/day mark. Individual units vary from 150 to 12,000 b/d. Several much larger units are now nearing completion; the largest unit so far designed but not yet installed is of 40,000 b/d capacity.

Initial investment and operating costs vary with each specific installation. Thus one 2,500 b/d unit has cost $50,000 ($20 per b/d of capacity), while a unit of 13,000 b/d now in design stages has been estimated to cost only some $150,000 ($11.53 b/d of capacity). Operating costs for the proposed 40,000 b/d unit have been estimated at 0.8 to 1¢ per barrel.

Except for one unit, the units operating at the present have been conversions from existing equipment, replacing Doctor and copper treaters and/or inhibitor sweetening or additional to inhibitor sweetening.

Plant Performances

One U.S. mid-western company (Case 1) with a small (4,000 b/d) refinery and the first to install a Merox unit, Universal Oil Products, reports it is successfully extracting 90% of the mercaptans from a mixture of light straightrun and full boiling range thermally cracked gasoline that contains from 0.1 to 0.12 wgt-% mercaptan sulphur. A solid bed catalyst is used in the sweetening section.

A 1,200 b/d Merox unit at a Canadian

refinery with solid bed sweetening is providing a substantial reduction in the mercaptan sulphur content of a gasoline-type (JP-4) jet fuel, going from 0.015-0.020 wgt-% in the change to less than 0.001 in the product.

At a western U.S.A. refinery, the unit is of the liquid/liquid type, in which the catalyst is in solution in caustic soda. Mercaptan sulphur content of the feedstock, a straightrun gasoline, is reduced from 0.009 wgt-% to Doctor sweet 0.0003 wgt-% or less. Catalyst consumption is 1lb. of catalyst per 18,000 bbls.

At another Canadian refinery there are two Merox units. One is a 2,200 b/d liquid/liquid type sweetener operating on a pentane fraction and reducing 0.04 wgt-% mercaptan sulphur to Doctor sweet. Catalyst consumption is again of the order of 1lb. of catalyst per 18,000 bbls., although it has ranged as high as 1lb. of catalyst per 77,000 bbls. The other unit at this plant is also a liquid/liquid type, and handles 6,000 b/d of full boiling range, fluid catalytically cracked gasoline. It reduces mercaptan content from 0.005 wgt-% to 0.0003 wgt-% (Doctor sweet) (Case B).

Doctor sweet, thermally cracked C_5-C_6 fraction is now obtained by another U.S. Western refiner. The Merox unit, a 750 b/d liquid/liquid sweetening type converted from existing equipment, produces the product from a charge stock containing 0.073 wgt-% mercaptan sulphur. At another plant, using F.C.C. gasoline feedstock with mercaptan sulphur content of 0.22 wgt-%, the Merox unit has reduced inhibitor consumption.

In a complex operation at another U.S. refinery successful operation on a 50-50 blend of light straightrun and coker gasoline at 6,000 b/d is reported. Coker gasoline, after passing through an extraction section of a steam-stripped regenerative caustic scrubber, joins light straightrun in flow through a liquid/liquid sweetener. Mercaptan content of the coker gasoline is reduced from 0.05 to 0.015 wgt-%. The light straightrun charge contains 0.0005% mercaptan. The blended material is obtained Doctor sweet. The refinery now plans to use Merox regeneration instead of steam stripping in the caustic scrubber.

Even more highly-branched, higher molecular weight mercaptans in kerosene can be successfully reduced, Universal Oil Products state. One commercial standard liquid/liquid sweetener, for instance, is reducing the mercaptan content of a 550°F end point kerosene from 0.006 wgt-% to Doctor sweet.

Attractiveness of the Merox process is due not only to the fact that it overcomes many inherent disadvantages of such conventional treating processes as copper or Doctor sweetening but because existing treating equipment can be quickly and easily converted. Thus one commercial unit combining extraction and sweetening used a scrubber and a copper sweetening unit. As finalised the Merox unit eliminated a number of the vertical vessels, all heat exchangers and the three copper sweetening unit reagent towers. The sole addition was a disulphide separator, also made from an existing vessel.

Table I—Typical Commercial Results with Merox Treating

Case	I	II		III	IV	V	VI	VII
Type of Merox	solid bed	solid bed		liq./liq.	liq./liq.	solid bed	solid bed	solid bed
Type of feedstock	JP-4	Visbreak gasol. (15%)	Straight-run gasol. (85.)	FCCU gasol.	FCCU gasol.	Light naphtha	Heavy naphtha	Thermal crack & LSR gasol
Feed API gravity ...	51.2	64.5	58.6	61	55.8	66.4	60.6	66
Feed RVP, psi ...	*	15	3.1	6.7	*	*	*	13.5
IBP, °F	176	103	139	106	115	98	130	93
10%	253	150	183	135	141	136	200	118
50%	310	235	237	199	224	220	274	199
90%	358	303	296	320	369	320	328	322
Feed RSH, wt-% ...	390	332	356	386	445	354	362	368
Feed blend RSH, wt-%	0.015–0.020	0.06	0.002	0.005	0.022	0.023	0.034	0.09
		0.0272						
Product RSH, wt-%	0.001	0.0001–0.0004		0.0003	*	*	*	0.0003
Product Doctor test	**	neg.		neg.	neg.	neg.	neg.	**

* Not reported. ** Meets jet fuel specification.

PASCO to Investigate Plant Operating Variables in Sulphuric Acid Manufacture

15 Tonne-a-day acid plant in operation and oleum plant planned

AS PART of its expanding consumer service programme, Pan American Sulphur Company is undertaking a long-term research and development study into the operating variables in the manufacture of sulphuric acid.

At its Jaltipan dome mine, adjacent to the existing sulphur purification plant, Pan American Sulphur Company has installed a small contact H_2SO_4 plant of the Monsanto-Leonard type. This plant has a daily capacity of 15 tonnes (about 6,000 short tons a year) of 100% sulphuric acid. Output will meet the company's sulphuric acid needs — hitherto purchased—for acid treatment of off-coloured sulphur whereby a proportion of hydrocarbons is removed and its colour improved to bright yellow.

The plant is designed to duplicate typical commercial practice. One of its functions will be as a research unit from which PASCO's engineers will obtain information and in which transient upset conditions can be duplicated and measured.

Area of Study

PASCO does not envisage that significant design changes will result from the study since current sulphuric acid manufacture is well developed and has a minimum of undesirable features. There is, however, an area for study involving the problems and irritations of operation at overcapacity, with impure feed materials, etc., and which bear heavily on sensitivity of operation, maintenance economy and air pollution control. Emphasis in this programme will therefore be placed on the development of information of value to those charged with the operation and maintenance of acid production facilities. Every effort is to be made to correlate the various studies so that they may be of immediate interest and utility to production.

In general the PASCO acid plant will be used to elucidate variations in operating behaviour which to date have been explained on the basis of rule-of-thumb experience, or explained in unpublished results.

General Programme

Information under the general headings, combustion of sulphur, oxidation of sulphur dioxide and hydration of sulphur trioxide to sulphuric acid, will be given in periodic progress and correlation reports. In addition supplementary sections will cover: Analysis of raw materials, products and gas streams; related studies which cannot be included logically in other sections; and case histories of plant problems.

Combustion of Sulphur

Pure sulphur combusted with dry air theoretically presents no problems. In practice the ease of burning sulphur of high quality has contributed to a neglect of those factors which might be altered with a less pure feed material. Thus few published data are available on gas composition in the burner flame, nitrogen oxide formation in the flame and on the refractory surfaces, quantity of sulphur trioxide formed in a particular burner, and quantity of acid mist which might be formed in the combustion gases with various qualities of sulphur.

The following projects will therefore be studied:—

Determination of mass transfer coefficients for water to sulphuric acid in the air-drying tower at temperatures normally encountered.

An investigation of the effect of moisture in feed material on combustion gas quality, acid formation in the burner, corrosion and erosion of exposed metal surfaces prior to the converter entrance.

An investigation of the effect of carbonaceous material (in particular petroleum) and inorganic ash on burning behaviour of sulphur and fluctuations of gas strength, and on slagging and decrepitation of refractory. This will include an examination of the behaviour of rust in the combustion zone, ash carryover and fallout.

Determination of temperature and pressure profiles in the furnace, along with volumetric combustion efficiency, hot spots and dead spaces.

An investigation of the heat exchange of hot combustion gas and the dust skin contribution to mist nucleation.

Evaluation of centrifugal and filtration devices for ash reduction in sulphur feed, including economics.

Examination of oxygen—enriched air for increased plant throughput.

SO_2 Oxidation

For commercial practice, published information is scarce on some of the more common aspects of the conversion of sulphur dioxide to sulphur trioxide. Projects established for a preliminary examination of the oxidation process include:—

An investigation of dust carryover and catalyst life, including vanadium volatilazation and migration and decrepitation of catalyst. Also, an examination will be made on the effect of rust and certain other inorganic salts on the life and activity of the catalyst. Fusion of catalyst by operation at elevated temperature level will also be investigated.

A study of factors contributing to acid mist nucleation and the effect of moisture and pre-converter mist on catalyst life and activity.

An investigation of corrosion and the effects of corrosion products on the catalyst, in particular, a measure of iron salt formation and erosion in the duct-work preceding the converter.

An examination of the effect of organic material on converter operation.

Hydration of SO_3 to Sulphuric Acid

Development of a control system for the emission of particulates would be facilitated with a fundamental examination of the factors involved in the generation of mist and in the absorption of SO_3 and acid mist particles in the absorber. While each absorber has its own optimum values of operating variables, an examination of the fundamentals of the absorption of the various species and of the mechanics of the absorption process would discover the source of the uniqueness. These considerations will occupy the major effort of the pilot plant programme :—

A determination of the mass transfer coefficients of SO_3 in sulphuric acid as a function of concentration and temperature.

An examination of fluid flow distribution and mist absorption, including devices for improving wetting efficiency.

A study of the effect of water quality and vessel corrosion on sulphation in the absorber with rate of plugging of distributors and packing.

An evaluation of certain mist filters and scrubbers including the relationship between pressure drop of the scrubbing device and plant capacity.

When sufficient data are available to orientate the programme, an oleum burner will be installed to investigate the variables of oleum production with emphasis on mist formation.

1960 A Good Year for U.S. Sulphur Industry Reports Freeport's President

"A GOOD year for sulphur" is how Charles A. Wight, president of Freeport Sulphur Company, New York, U.S.A., described 1960 in his annual review of the sulphur industry. Domestic consumption and exports were both at record levels and there were important additions to the industry's productive capacity. For the second consecutive year, as a result of the high rate of industrial production in the U.S. and abroad, demand increased.

Preliminary data given by Wight indicates that total domestic consumption of sulphur in all forms was in excess of the previous high level of 5,950,000 long tons used in 1959, when consumption was 11% over that of 1958.

The high level of industrial activity in the free world led to greater than ever exports of sulphur. Shipments are estimated by Freeport to total 1.7 million tons, up 100,000 tons over those of 1959. The new high level was achieved despite an increase of 600,000 tons in the shipments of other producers supplying the overseas markets. Domestic sulphur production rose 7%, Mr. Wight reports. Output from all sources amounted to an estimated 6.6 million tons, compared with 6,165,000 tons in 1959. Of the total, an estimated 4,950,000 tons was elemental sulphur mined by the Frasch process in Texas and Louisiana. Of the balance, 725,000 tons (estimated) represented elemental sulphur recovered from sour natural gas and refinery gases; 425,000 tons sulphur contained in pyrites, and 500,000 tons sulphur in various forms from other sources.

Major importing countries of U.S. sulphur and the estimated tonnage shipped were as follows:—

United Kingdom	310,000 tons
Canada	300,000 tons
Australia	140,000 tons
India	140,000 tons
Brazil	130,000 tons

All sales of U.S. sulphur outside the North American Continent were handled by Sulexco (Sulphur Export Corporation).

current events

CANADA

New Location for Barvue Mill Project

An option has been taken by the Sumitomo group of Japan on the 5,000-ton-a-day capacity Barvue zinc concentrator and plant now owned by Manitou-Barvue Mines. The intention is to move the now idle mill from the Barraute district in northern Quebec to Highland Valley B.C. Purchase price is reported to be $1.5 million.

Previously Aluminium Company of Canada Limited (Alcan), had arrangements with Barvue Mines to roast the latters zinc concentrates at Alcan's Arvida plant. The sulphur dioxide in the roaster gases was used to produce up to 50,000 short tons of sulphuric acid a year which was consumed within the company's works; the zinc calcines were shipped to American Zinc Lead and Smelting Company of Illinois, U.S.A.

If the Japanese option is taken up and the plant is transferred to Highland Valley, chemical industry in East Canada will be deprived of up to 50,000 tons of sulphuric acid. Whereas in the West, where recovered sulphur producers look to a rapid expansion of outlets, the transferred by-product acid plan may not be welcomed.

Sherbrooke Plants in Operation

Now in operation at Port Maitland, Ontario, are the new £1.9 million facilities of Sherbrooke Metallurgical Company for roasting zinc and producing sulphuric acid. In the main zinc treatment plant, a roasted zinc concentrate is produced, which has some of the sulphur removed. Gases from roasting, composed mainly of sulphur dioxide, are used to produce sulphuric acid.

First of its kind in North America, the plant uses a pelletized fluid hearth process. It handles concentrates produced by zinc mines in Eastern Canada, en route to the smelter of Sherbrooke's parent company, Matthieson and Hegeler Zinc Company, La Salle, Illinois.

Governing capacity is the acid producing plant which is rated at 450 tons daily. The latter has been in operation since the end of October, and includes a sulphur burner, producing sulphur dioxide directly from imported element sulphur. The acid produced is sold under a long agreement to Electric Reduction Company of Canada Limited, which will use the acid to produce superphosphate fertilizers and at a later date detergent raw materials.

INDIA

Travancore Sulphuric Acid Plants

Now in operation at Travancore Titanium Products (Pty.) Limited is a new 50-ton-a-day (100% H_2SO_4) brimstone-burning contact sulphuric acid plant, designed, engineered and installed by Chemiebau Dr. A. Zieren GmbH.

A large part of the plant, including all the tanks, contact plant, towers and structural ironwork was produced in India, to Chemiebau technical data and specification. The cast iron parts, brick material, waste heat boiler, heat

Sulphuric acid plant built by Chemiebau Dr. A. Zieren GmbH for Travancore Rayon (Pty.) Ltd.

exchangers, measuring instruments, pumps, blowers and motors have been supplied from Germany.

This sulphuric acid plant has been operating to the entire satisfaction of Travancore Titanium. The entire output is being used in the titanium oxide pigment plant.

A similar plant has also been installed for Travancore Rayon Limited, Rayonpuram; this also has a capacity of 50-tons-a-day of sulphuric acid.

Premier Fertilizers Plant Projects

The recently formed Indian company, Premier Fertilizers Limited, is to put up a plant at Cuddalore, in Madras State for production of superphosphate and sulphuric acid. Annual capacity planned is 40,000 tonnes of superphosphate and 16,500 tonnes of sulphuric acid (100% H_2SO_4). Total cost of the plant is estimated at 6,350,000 rupees (£47,000).

Ready to grant the equivalent of U.S. $235,000, as a loan to cover the cost of equipment imports for the new plant is the Industrial Credit and Investment Corporation of India Limited. It is expected that plant and equipment will be supplied and set up by the West German concern, Chemiebau Dr. A. Zieren GmbH of Cologne.

UNITED STATES

American Cyanamid's New Acid and Superphosphate Plants

Doubling production of wet-process phosphoric acid at its Brewster, Florida, plant is American Cyanamid Company. The expansion is designed to increase output of triple superphosphate. Associated with this expansion is a new sulphuric acid plant at the site which will have a capacity of 275,000 tons of 100% H_2SO_4 a year, based on brimstone. The construction contract has been awarded to Leonard Construction Company. This new sulphuric acid plant will be American Cyanamid's tenth plant, and will bring the company's installed capacity close to one million tons of acid a year.

Open Sulphur Mine in California

Under development since January 1959 by the American Mineral Resources Development Company in Lake County, California, has been the S Bar S open pit sulphur mine. According to geological estimates the mine has a sulphur tonnage of some 15 million tons averaging 15% sulphur.

Several drill holes have been put down to determine the depth of the overburden and general trend of the enriched ore zone. Development to date consists of two 60-foot adits, three six-inch rotary drill holes, and the open pit where approximately 25,000 tons of sulphur-bearing materials have been removed. The deepest drill hole bottomed at 177 feet in 22.5% sulphur and averaged 18.26% through 127 feet of tuff. Actual depth of the ore body has not yet been determined since one drill hole to a depth of 180 feet in marketable ore had to be abandoned.

The deposit consists of sulphur disseminated in a highly altered body of tuff containing fragments of obsidian and pumice. It covers an area of 37 acres. Surface mining is continually expanding the enriched ore zone and the surface exposure of 30 to 80% sulphur presently embraces over three acres. The area of the mine covers about 140 acres.

American Mineral Resources is currently mining with a front-end loader and marketing a product to Sacramento Valley farms called S Bar S Soil Sulphur, containing 13% sulphur, which is sold through Goforth Brothers of Williams, California. The sulphur is transported to Williams where it is crushed and screened and sold to local farmers who have a sulphur deficiency in their soils. Future plans are to provide raw sulphur for the chemical and sulphuric acid industries in western United States.

MEXICO

Government Directive on Sulphur Royalties

Liquidation of royalties charged on Pan American Sulphur Company's Frasch sulphur, by General Afredo Breceda, Manuel Urguidi and Mr. L. Brady one of the three brothers who discovered and developed the dome sulphur reserves on the Isthmus of Tehuantepec, has been ordered by the Mexican Minister of National Patrimony, Eduardo Bustamente.

If this directive is not implemented shortly, direct official measures are to be taken to suppress the royalties.

Also announced by the Minister is the cancellation of idle mining concessions and those operations not in line with the new mining law. This legislation, the Minister stated "is not inspired by xenophobia but the desire to take advantage of the country's wealth for the benefit of the Mexican society as a whole."

According to the Government, Mexican sulphur companies have paid Braceda, Urguidi and Brady 102 million pesos (U.S. $5.2 million) in royalities from 1954 to date. From a technical standpoint, the Government is stated to be in full control of Mexico's sulphur reserves and is aware of their true extent. In this respect it is stated that sulphur reserves on the Isthmus of Tehuantepec have been proved to amount to 60 million tonnes and additional exploratory work points to the existence of at least 50 million tonnes more. Thus at the present rate of mining, and if new deposits are not discovered, sulphur can continue to be mined for 50 years hence.

GREECE

Hellenic Company's Acid Plants

Sole producer at present in Greece of sulphuric acid, superphosphate fertilizers and pyrites is Hellenic Company of Chemical Products and Fertilizers Limited, Athens, Greece. The company has two sulphuric acid plants at its Piraeus works — one a contact type and the other a Petersen tower plant, both based on indigenous pyrites. Acid production of 100% H_2SO_4 is currently about 120,000 tonnes a year. Some 124,000 tonnes is required for superphosphate (16% N - 20% P_2O_5) fertilizer manufacture, and 10,000 tonnes for various chemical products and other industrial uses.

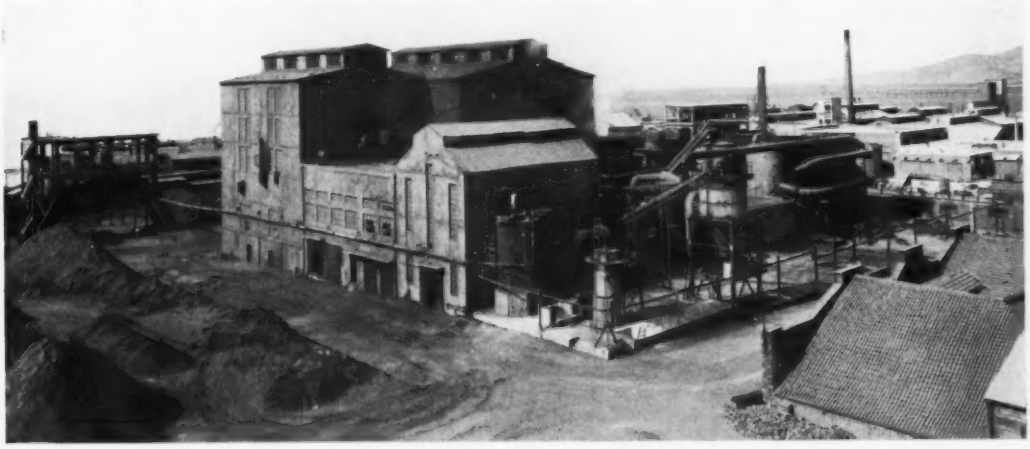
Since 1957, Hellenic Company has carried out major improvements and repairs to increase sulphuric acid production. Prior to the installation of the contact acid plant in 1953 up to 50,000 tonnes of sulphuric acid had to be imported. Since then the company has been able to reduce imports of sulphuric acid substantially.

WEST GERMANY

Bayer's New Sulphuric Acid Plant

Farbenfabriken Bayer A.G., of Leverkusen, West Germany, is opening two new hearth roaster furnaces with a combined daily capacity of 200 tonnes of sulphuric acid. The furnaces replace a battery of old pyrites lump roasters having a capacity of 165 tonnes a day and will permit the processing of pyrites with a considerable arsenic content. Unlike the single-stage fluidized furnaces, hearth roasters have traditionally been suitable for roasting arsenical pyrites giving clean acid and arsenic free iron residues.

The company also has another sulphuric acid unit at Urdingen having a capacity of 175 tonnes a day based on ferrous sulphate. Of



The contact sulphuric acid plant at the Piraeus works of the Hellenic Company of Chemical Products and Fertilizers Limited

considerable interest are the satisfactory results obtained in the company's sulphuric acid operations based on ferrous sulphate derived from titanium dioxide wastes.

EAST GERMANY

Limonite for H_2S Removal

Limonite, a low-grade iron ore often found mixed with magnetite and clay, is reported to be in use at coking plants in East Germany to remove hydrogen sulphide from fuel gas streams.

Feed streams containing 15 grams per cubic metre (655 grains/100 cubic foot) of hydrogen sulphide have been purified to less than 20 mg. per cubic metre. During the absorption, ferric hydroxide in the limonite is converted into ferrous sulphide and water. Air-blowing regenerates hydroxide.

This process will be used in a plant currently under construction, which will handle 8.5 million cu. ft./day of gas. Six towers are used operating in parallel, each 52ft. high and 8.5ft. in diameter with 10 trays of limonite suspended inside. Operating pressure will be 150 p.s.i.g.

YUGOSLAVIA

Yugoslavia's Superphosphate Production

Now undergoing trial operations is Yugoslavia's large new superphosphate plant at Prahovo, of 575,000 tons a year capacity which is geared for a potential expansion to 1 million tons a year. When the unit is in full production in mid-1961 about 153,000 tons of superphosphate are expected to be available for export. This is based on domestic consumption of 667,000 tons, including 125,000 in mixed fertilizers as against total output of 830,000 tons. About 400,000 tons of superphosphate will be produced at Prahovo during the first year's operation. The plant will be the largest chemico - metallurgical plant outside the U.S.S.R.

Using the nearby Danube as a waterway, the Prahovo plant will receive crude phosphates from Jordan, process them with sulphuric acid and other locally available materials and ship the finished product to distribution points around the country and to some overseas markets.

Reports indicate that the plant will produce a particularly low-cost product, based on the use of by-product sulphuric acid which is obtained from processing of pyrites and copper at the nearby installation of Bor. Two Peterson tower sulphuric acid plants for Rudarsko - Topionicarski Bayen Bor at Bor are now practically completed by the constructors Hugo Peterson AG. of Berlin. Production will be 900 tonnes 60° Bé H_2SO_4 a day. The Petersen plants are adjusted to optional conversion of the variable strengths of SO_2 gas which will be piped from the smelter exit to the sulphuric acid plants.

U.S.S.R.

H_2SO_4 Sludge Wastes Yield Selenium

From sulphuric acid sludge and wastes of the cellulose industry, the Shebelkovo Chemical Plant extracts selenium and tellurium using a process it has developed in co-operation with the U.S.S.R. State Institute of Non-ferrous Metals. The wastes contain 3 to 5.2% selenium and from 0 to 14% tellurium.

Sludge is sintered with sodium carbonate, leached and filtered, with both the selenium and the tellurium going into the filtrate. Tellurium is precipitated by addition of hydrochloric acid and filtered selenium is precipitated from the filtrate by means of sulphur dioxide gas.

Reporting on the process in *Tsvetnyyemetally*, 1960, No. 3, 55, L. A. Soshnikov and M. Yezernitskaya state that the new procedure has many advantages over the old process of oxidation roasting.

PORTUGAL

Sulphur Recovery by Sacor

At the oil refinery of Sacor (Sociedade Anonima Concessionairi de Refinacao de Petroleos em Portugal) at Cabo Ruivo, Lisbon, Portual, H_2S extracted from refinery gases has hitherto enabled the company to recover about 1,900 tonnes brimstone a year, which corresponds to about 83% of the company's maximum production capacity. Now Sacor plans to expand some of its existing facilities, in particular the T.C.C. unit which will result in large quantities of hydrogen sulphide becoming available. The company expects to increase output of recovered sulphur in its Claus unit up to about 3,200 tonnes a year.

COMPANY REPORTS

Formation of a Merger by K.N.Z. and Ketzen Under Consideration

ACCORDING to an announcement in mid-January close co-operation is under consideration between N.V. Koninklijke Nederlandsche Zoutindustrie (Royal Netherlands Salt Works Limited), Hengelo, and Koninklijke Zwavelzuurfabrieken V/h N.V. (Royal Sulphuric Acid Works—lately known as Ketzen Limited), Amsterdam. The companies are considering the formation of a joint holding company, the shares of which would be exchanged for those issued by the operating companies.

In the event of a successful outcome of the negotiations, both managements have in mind an evaluation of the shares of their respective companies on the basis of nominal Hfl.500-K.N.Z. shares as compared with nominal Hfl.1,000 Ketzen shares.

Both companies are expected to close their accounts for 1960, and an exchange of shares, if any, will be effected ex-dividend 1960.

From the present discussion it is proposed that the management of the new holding company will consist of two managing directors, one to be recruited from Ketzen and one from K.N.Z.

K.N.Z. is proposing to pay a cash dividend of 15% for 1960 (same as 1959). In addition to this, a payment of 5% in bonus shares is contemplated. Ketzen also propose a cash dividend of 12%. In 1960, shareholders of Ketzen received an additional 2½% in cash on the occasion of the 125th anniversary of its foundation.

EDITORIAL NOTE — In 1959, K.N.Z. acquired Albatros Superfosfaatfabrieken N.V., the largest phosphate fertilizer producer in the Netherlands. The company also has a 20% share jointly with Ketzen and Maatschappij tot Exploitatie van Kooksovengassen (Mekog) in Nederlandsch Verkoopkantoor voor Chemische Producten N.V. of Amsterdam, which also handles the sales of some of the chemical products of the Dutch States Mines.

Ketzen is the oldest sulphuric acid producer in the Netherlands, manufacturing acid for sale and products associated therewith such as sulphuric dioxide. One of the company's specialities is a variety of catalysts for oil refineries — including cracking catalyst, hydroforming catalyst and hydrodesulphurization catalyst. In 1940, Ketzen started production of saccharin and later the manufacture of base materials for saccharin and decided in 1959 to build a phenol plant. In the same year (1959) Ketzen obtained a 63% participation in Ketzen Carbon N.V. Another participation is in Cyanamid—Ketzen N.V. with American Cyanamid which manufactures platinum catalysts.

Subsidiaries include Industriële Maatschappij Activit N.V. which makes iron-exchange resins and this latter company's subsidiary Duper Waterreiniging N.V.

K.N.Z. owns salt mines in the eastern part of the Netherlands and in 1959 aquired Chemische Fabriek Gombo N.V. which produces among other products various silicates, detergents, soda and borax, and DM. 791,900 shares in Stader Saline G.m.b.H. at Stade, a salt producer.

Montecatini's Production of Pyrites at High Level in 1959, but Sulphur Output Down

DURING 1959 Societa Montecatini's production of pyrites, including cupriferous pyrites from Boccheggiano, Fenice Capanne and Libiola, was maintained at the very high level of the previous year —about 1,365,000 tonnes. This compares with total Italian production which was 1,522,000 tonnes.

Equipment of the Maremma mines is being improved and research is being intensified in order to exploit the mines to the utmost. The pyrites residues remain an attractive asset for the Italian steel industry.

Sulphur Production

Output of sulphur by Soc. Montecatini was reduced to 33,844 tonnes and will decrease still further in the future, the company state. Italian production of sulphur diminished still further, from about 161,000 tonnes in 1958 to 121,000 tonnes in 1959. Also expected to affect indigenous sulphur mining is sulphur recovered at oil refineries and from natural gas sources.

Phosphate Fertilizers

Superphosphate equipment, particularly for granulated and high-grade superphosphate, is being maintained by Montecatini in full efficiency, so that if required production of P_2O_5 in this form can be raised, in addition to that supplied in mixed and complex fertilizers. Production of phosphate fertilizers was 1,115,000 tonnes in 1959 as against 1,143,000 tonnes in 1958.

STATISTICAL APPENDIX

CYPRUS EXPORTS (Long Tons)

Cupreous Pyrites

Destination	1959	Jan.-Oct. 1960
Belgium	24,045	10,951
Germany, West	45,664	47,204
Italy	54,130	32,451
Netherlands	183,187	126,010
Total	**307,026**	**216,616**

Iron Pyrites

Destination	1959	Jan.-Oct. 1960
United Kingdom	152,107	181,242
Belgium	52,147	54,722
France	165,849	150,031
Germany, West	136,968	99,313
Italy	43,480	123,318
Netherlands	105,819	72,745
Others	—	380
Total	**656,370***	**681,751**

* Excludes 3,000 tons to New Zealand reported in the official figures.

YUGOSLAVIA EXPORTS (Metric Tonnes)

Iron Pyrites

Destination	1959	Jan.-Mar. 1960
Austria	6,192	650
Czechoslovakia	10,001	—
Italy	35,779	18,679
Hungary	4,126	—
Poland	58,454	—
East Germany	55,536	12,748
Egypt	16,000	—
Total	**186,088**	**32,077**

GREECE EXPORTS (Metric Tonnes)

Pyrites

Destination	1959	Jan.-Sept. 1960
Austria	6,750	11,135
Italy	—	5,600
Netherlands	29,616	20,460
Total	**36,366**	**41,935**

CANADA (Short Tons)

Sulphur Imports

Destination	1959	Jan.-Aug. 1960
United States	327,614	184,422
Mexico	4,815	—
Total	**332,429**	**184,422**

Sulphur Exports

Destination	1959	Jan.-Sept. 1960
United States	26,526	91,575
Total	**26,526**	**91,575**

Pyrites Exports (Dollar Value)

Destination	1959	Jan.-Sept. 1960
United Kingdom	217,064	46,220
Netherlands	—	110,275
United States	801,544	811,787
Total	**1,018,608**	**968,282**

NORWAY EXPORTS (Metric Tonnes)

Pyrites

Destination	1959	Jan.-Sept. 1960
Denmark	56,340	35,300
Sweden	77,836	62,128
Germany, West	216,598	204,359
Others	57,386	22,087
Total	**408,154**	**323,874**

PORTUGAL EXPORTS (Metric Tonnes)

Iron Pyrites

Destination	1959	Jan.-Nov. 1960
Germany, West	60,701	82,086
Belgium/Luxembourg	134,963	144,264
France	62,777	29,775
Netherlands	84,889	60,720
Algeria	1,170	—
Eire	3,608	—
Tunisia	7,225	—
Morocco	1,500	—
Total	**356,563**	**316,845**

CANADA

	Alberta – Kaybob								British Columbia		
	Jumping Pound	Nevis	Okotoks	Pincher Creek	Red Water	Turner Valley	TOTAL	Stocks*	Sales†	Production	Sales	Stocks*
1958 Total	**32,325**	—	—	**77,926**	**1,732**	**10,343**	**122,326**	**110,996**	**91,553**	**62,604**	**1,469**	**66,496**
1959 Total	**31,222**	**1,587**	**58,826**	**134,753**	**1,858**	**10,398**	**238,694**	**185,720**	—	**53,693**	**45,217**	**74,724**
1959												
July	2,022	—	6,265	5,912	190	527	14,916	95,042	14,087	3,772	4,410	69,090
Aug.	2,132	—	7,422	11,327	193	870	21,944	109,341	7,884	4,275	2,411	70,945
Sept.	2,045	—	7,209	10,988	234	866	21,342	125,566	4,984	3,806	3,978	70,774
Oct.	2,668	—	10,865	12,643	147	911	27,234	144,091	8,569	4,892	2,943	72,723
Nov.	3,186	—	10,812	13,455	115	867	28,435	162,508	10,066	4,805	4,509	73,018
Dec.	2,595	1,587	11,959	17,381	204	885	33,036	185,720	—	5,448	3,743	74,724
1960												
Jan.	3,202	2,174	12,319	17,679	218	966	36,558	211,072	10,918	5,420	3,196	76,948
Feb.	2,951	5,099	11,413	16,843	152	861	37,319	235,215	11,667	5,007	3,328	78,627
Mar.	2,931	2,822	11,925	14,356	159	509	32,702	253,052	14,460	5,194	2,792	81,029
Apr.	2,631	2,704	11,435	16,399	87	755	34,011	271,045	15,401	5,162	3,650	82,551
May	2,228	‡	‡	13,001	46	892	16,167	279,721	7,436	5,262	3,312	84,501
June	2,179	5,183	23,903	9,459	249	309	41,282	272,969	46,886	4,803	2,566	86,738
July	2,017	2,475	4,543	10,326	56	774	20,191	267,282	25,881	4,597	2,652	88,683
Aug.	2,313	1,540	7,658	7,279	89	751	19,630	265,387	21,598	—	—	—
Sept.	2,475	1,382	11,478	9,951	142	810	26,238	270,979	20,398	—	—	—

* Stocks at end of period shown. This figure is not merely the accumulation of difference between production and sales, as small tonnages of sulphur are internally consumed and there are also minor monthly adjustments.

‡ Not reported.

† Sales in Alberta.

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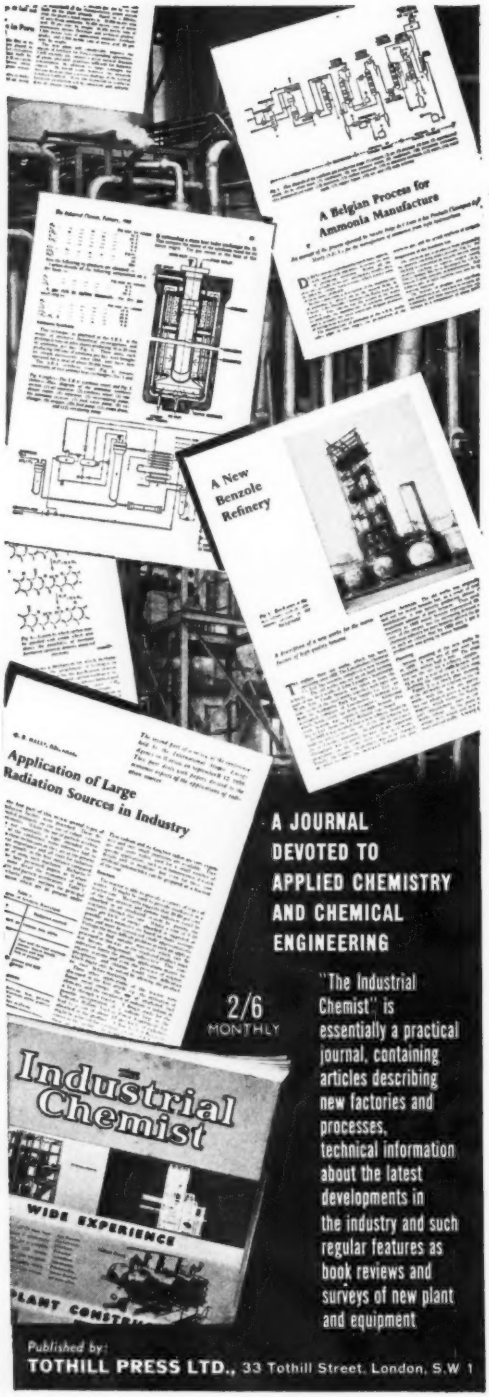
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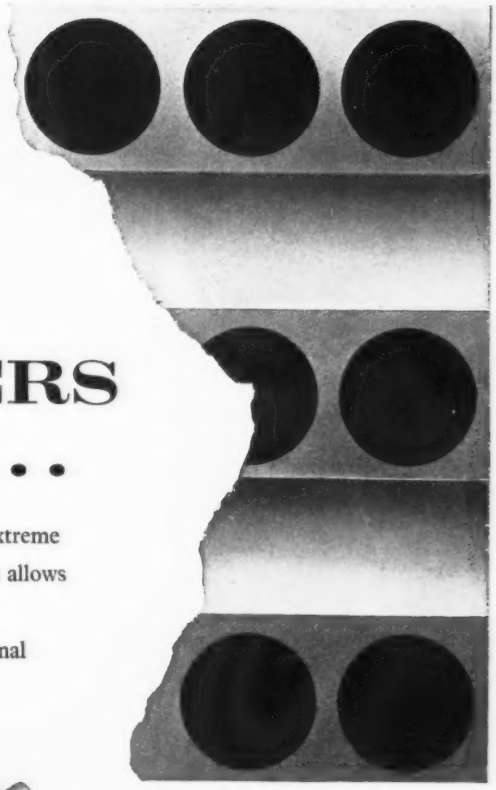

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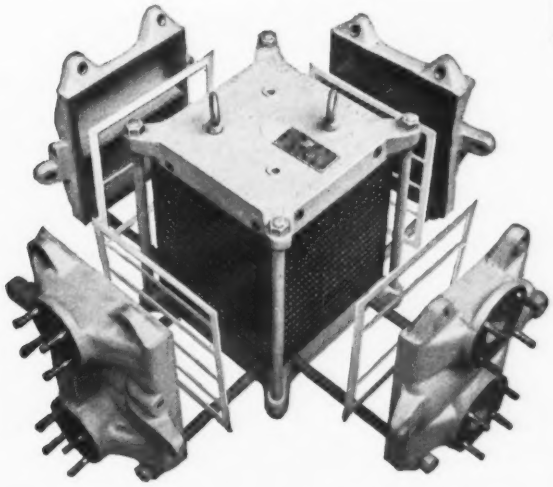

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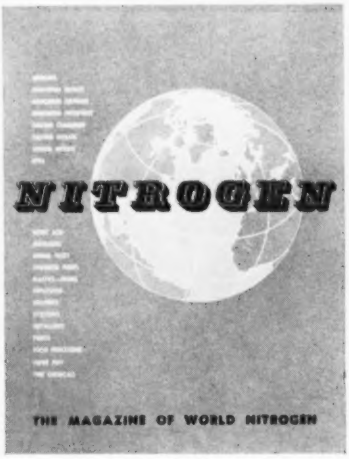

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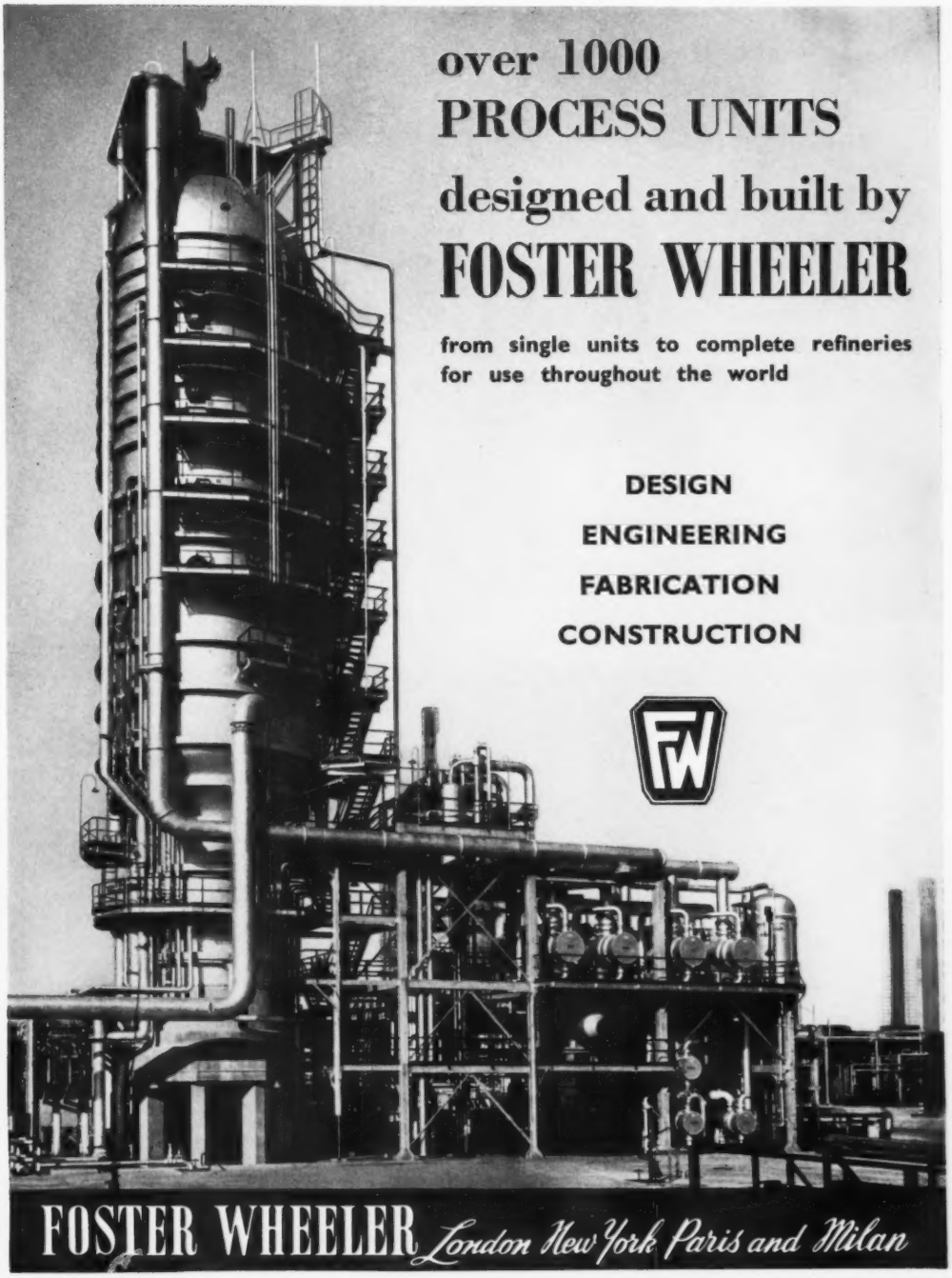
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